SAE journal

OCTOBER 1955

IN THIS ISSUE . . .

PACKARD'S torsion level suspension system 22

BUICK SWITCHES the pitch of its Dynaflow Transmission stator vanes for better efficiency 28

MORE BANG PER BUCK is goal of aircraft designers 30

SKY-HIGH overdrive: the jet stream 40

WHAT makes rubber tend to crack? 44

BEECROFT MEMORIAL LECTURE: Traffic Engineering. . .64

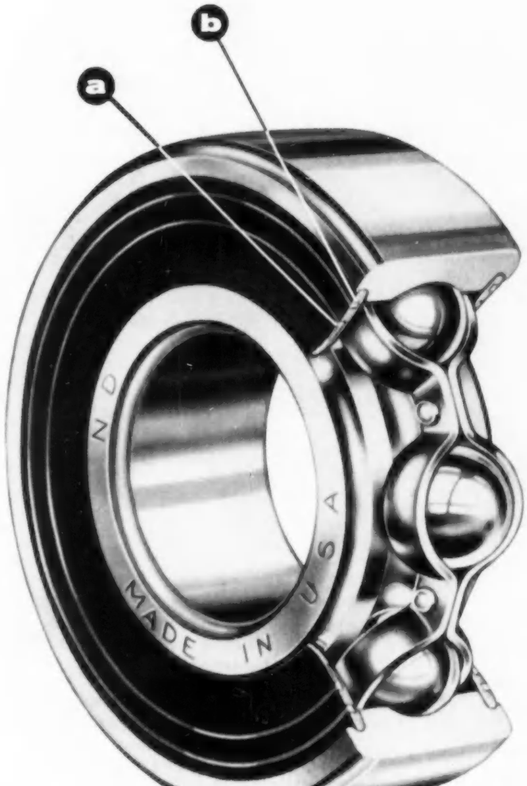
Table of contents on page 15

Published by The Society of Automotive Engineers

FACTS

about

NEW DEPARTURE
BALL BEARINGS



New Sentri-Seal...on guard against dirt and wear!

The unique design of the Sentri-Seal gives optimum protection against dirt, and includes a number of other major advantages.

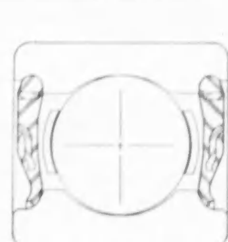
Sentri-Seals are quickly removed, easily replaced. As the seal is of synthetic rubber, in which two metal rings are embedded, a constant-rate spring is created between the rings. Inherent flexibility prevents distortion of the bearing outer ring due to seal insertion, permitting the use of bearings to the higher accuracy specifications. The spring action maintains an efficient sealing contact with the bearing ring to bar dirt and retain lubricant. Sentri-Seals are relatively inert to oils and greases and operate satisfactorily through a temperature range of −40°F to 225°F. Specifications available for still higher temperatures. In applications where relubrication is desired, it is easily accomplished by the injection method.

The New Departure Sentri-Seal basically consists of two separate metal rings, "A" and "B", embedded in synthetic rubber, resulting in a spring which absorbs distortion and deflection. The seal is not drastically influenced by axial displacement due to bearing end-play within prescribed tolerances, and provides efficient sealing at low torque. Bearing shown is equipped with two seals.

ONE SENTRI-SEAL | SEAL AND SHIELD | SEAL AND SNAP RING | TWO SEALS AND SNAP RING | SEAL, SHIELD AND SNAP RING

The diagram shows in section the New Departure Sentri-Seal. Lip contacting surfaces are form-ground simultaneously with the ball race, giving an extremely high degree of concentricity between sealing surfaces and the raceway.

Sentri-Seal is available for a range of sizes in single-row, standard-width bearings and also in two types of New Departure adapter bearings. Sizes, dimensions and capacities are listed in the latest New Departure catalog.



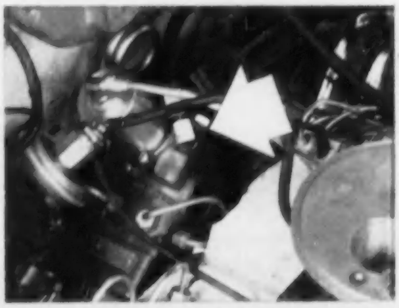
Write for full details on Sentri-Seal

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

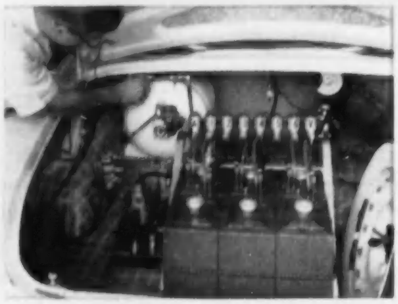
SAE JOURNAL, October, 1955, Vol. 63, No. 10. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office, at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 29 West 39th Street, New York 18, N. Y. $1 per number; $10 per year; foreign $12 per year; to members 50 cents per number, $5 per year. Entered as second class matter, September 15, 1948 at the Post Office at Lancaster, Pa., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1948. Additional entry at New York, N. Y.


Be Emphatic!
Specify
GM STEEL TUBING
By Rochester Products


I'm goin' to Californy with no place to put my Knee-e-e-e-



The arrow is pointing to the Du Pont test car's fuel-injection pump, which is driven by the same shaft as the distributor.



From these tanks in the trunk, any of six different fuels can be selected for testing in the fuel-injection engine.

Fuel-injection car being tested on Du Pont Petroleum Laboratory's chassis dynamometer.

Special Du Pont test car studies advantages of *fuel-injection*

Will fuel-injection soon replace our standard carburetor system? As yet, no one knows the answer! But there are certainly many advantages to recommend it . . . such as freedom from carburetor icing, reduction of vapor lock troubles and improved power. And it will permit automobile styling changes since the hood lines can be lowered.

But how would a trend to fuel-injection engines affect the refiner? As a large supplier of the chemical additives used to improve fuel performance, we at Du Pont are interested in this development. And to study it thoroughly, the Du Pont Petroleum Laboratory is using a specially equipped test car.

The car has a Lincoln V-8 engine to which has been added an American Bosch fuel-injection system and special instrumentation. In addition to road work, the Petroleum Laboratory has tested the car on the Laboratory's chassis dynamometer.

From testing it with a variety of gasoline blends, the Laboratory has found that *fuel-injection permits greater flexibility in blending fuels. Fuel components with higher vapor pressures can be used, and it is possible that increases in the use of higher end point fuels may be practical. These wider tolerances could result in significant economic advantages to refiners,* as well as welcome benefits to the motoring public.

The Du Pont Petroleum Chemicals Division now has this car on a demonstration tour throughout the United States.

DU PONT

REG. U. S. PAT. OFF.

Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

Regional Offices:
NEW YORK, N. Y.—1270 Ave. of the Americas . . Phone COlumbus 5-2342
CHICAGO, ILL.—8 So. Michigan Ave. . . . . Phone RAndolph 6-8630
TULSA, OKLA.—P.O. Box 730 . . . . Phone LUther 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . . Phone CApitol 5-1151
LOS ANGELES, CALIF.—612 So. Flower St. . . . . . . Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond St. W., Toronto 1, Ont.
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Building, 6539—Wilmington 98, Delaware

Passenger Model Mercedes cars have adopted nickel cast iron brake drum liners because of the notable successes of Mercedes-Benz "Silver Arrow" racing cars so equipped in rigorous trials such as the Le Mans 24-Hour Road Race.

Nickel cast iron lines brakes of new 240 hp Mercedes 300 SL series cars

THIS RADIALLY FINNED brake drum for the new Mercedes model 300 SL embodies an Al-Fin bonded friction liner of nickel cast iron.

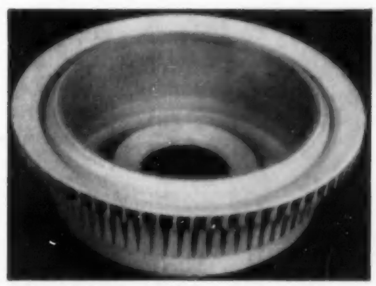
Fortified with nickel, the liner not only resists uneven wear from thermally induced stresses, but it also dissipates intense frictional heat from internal surfaces through the aluminum to the air, thus preventing "brake fade." In addition, it resists warpage.

And particularly important, in spite of irregular but rigorous cycles of heating and cooling, it resists heat-checking.

Life expectancy of cast iron parts can be materially increased by adding suitable amounts of nickel to properly adjusted base mixtures. In this way you improve structure, mechanical strength, thermal expansion characteristics and stability at elevated temperatures.

Nickel alloys have answered exacting demands throughout the automotive and allied industries. Whatever your metal difficulty, let us give you the benefit of our wide practical experience in this field.

Write for List A of available publications. It includes a simple form that makes it easy for you to outline your problem.



The friction liner of this Mark II type radially finned brake drum contains 0.80-1.00% nickel along with molybdenum and chromium. Ferrous liners are bonded into the cast aluminum drums by the Al-Fin process, a development of the Al-Fin Div., Fairchild Engine and Airplane Corp., Deer Park, N. Y.

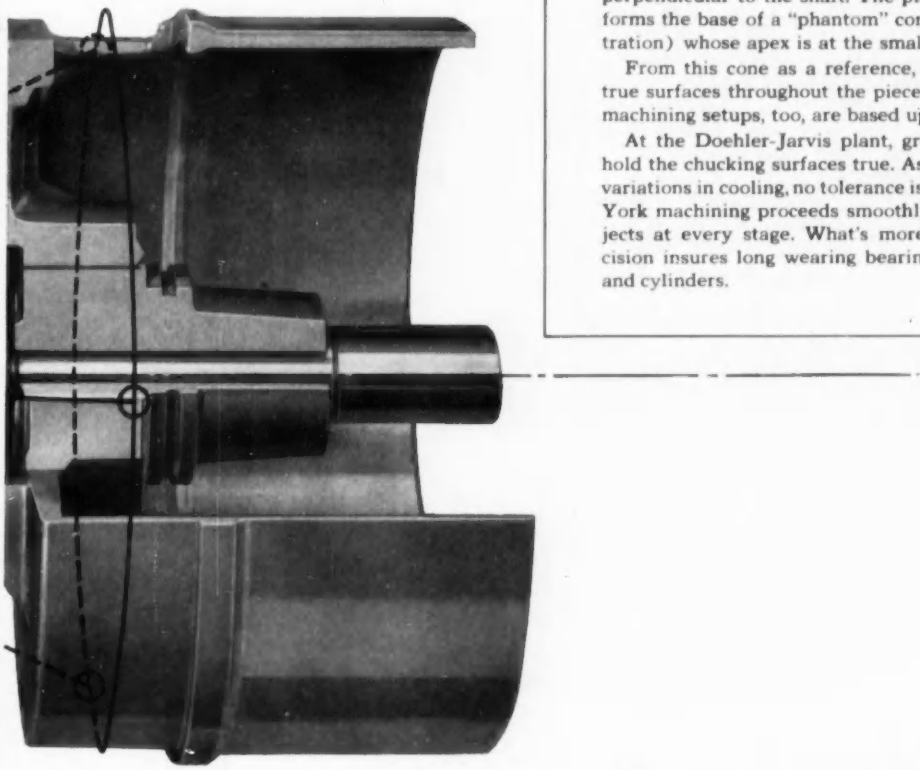
INCO **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

"Phantom" control cone, with three "no tolerance" chucking surfaces, establishes precision

In the raw casting three equidistant chucking surfaces are established by the Doehler-Jarvis die. Their centers are located on a circle concentric with and exactly perpendicular to the shaft. The plane thus established forms the base of a "phantom" control cone (see illustration) whose apex is at the small bearing bore.

From this cone as a reference, all center lines and true surfaces throughout the piece are established. All machining setups, too, are based upon it.

At the Doehler-Jarvis plant, great care is taken to hold the chucking surfaces true. Aside from very slight variations in cooling, no tolerance is allowed. As a result, York machining proceeds smoothly with minimum rejects at every stage. What's more, the resulting precision insures long wearing bearings, long life pistons and cylinders.



more compact through die casting

die for three "no-tolerance" chucking surfaces on the raw casting . . . precisely located with respect to the front bearing bore.)

This expert product engineering team went on to develop for other sizes other integrated die cast housings, and the connecting rods, pistons, main bearings, and oil slinger rings. These compressors are light, compact and highly efficient. They can be produced quickly and easily.

"Cannot be matched for low cost," York says

"What's more, because the parts can be die cast in a hurry . . . and because Doehler-Jarvis never fails us on delivery . . . we stay flexible. We're able to meet peak demands for air conditioners without going overboard on finished inventory."

Come back to the things you want to do for your own product . . . maybe Doehler-Jarvis could help you do them with die castings. We've done it for scores of manufacturers, large and small—including makers of home appliances, office and public utilities equipment, industrial machines, and many other similar products made better with die castings.

So, if you are engineering a new product or improving the one you have, call in Doehler-Jarvis. With more than fifty years experience behind us, we may be able to contribute in many ways.

Doehler-Jarvis Division

of

National Lead Company

General Offices: Toledo 1, Ohio

For the Sake of Argument

Exactness in Making Decisions . . .

By Norman G. Shidle

Decisions which involve action by more than one person usually point the action in some *direction*. Only infrequently do they give start-to-finish details for completion.

That's because action has to be molded by a joint movement of minds throughout its course. It involves the emotions, reactions, and attitudes of the people involved in the project. These are hard to "compile" exactly in advance. Yet, they often outweigh the "facts" in importance in getting the result.

Great leaders in almost every area have improvised during action—without changing their objectives. Faced with non-contemplated conditions, they haven't hesitated to change both plan and method while still in motion. . . . The *most* inexact results can come from following—without awareness to change—an original program too exactly detailed.

Success in decision-making is only partly conditioned by the exactness of the facts on which it is based. The thinking done about the facts counts, too.

Some folks are rarely wrong about a fact; others are rarely exactly right. . . . Some come to sound conclusions from slightly fuzzy facts; others to widely erroneous conclusions from very exact data.

"If something has to be a little less than perfect," we heard an executive say recently, "perhaps it had better be the facts rather than the thinking. Loose logic can cause more trouble than facts which rattle around a little in the pod of truth."

The first step in thinking about any set of facts, of course, is to evaluate its character, its quality . . . and its limitations. A plan based on that knowledge may get top results for far less time-dollar expenditure than going back to "exact" the data.

Applied to decision-making, a too meticulous mentor can be a tree across the path of progress . . . or even a cook who actually spoils the broth.

SAE journal

Norman G. Shidle
Editor

Joseph Gilbert
Managing Editor

SAE JOURNAL PUBLICATION OFFICE
Business Press, Inc.
10 McGovern Ave.
Lancaster, Pa.

EDITORIAL OFFICE
29 West 39 St.
New York 18, N. Y.
Tel.: LOngacre 5-7174

ADVERTISING OFFICES
E. D. Boyer
Eastern Advertising Manager
29 West 39 Street
New York 18, N. Y.
Tel.: LOngacre 5-7170

W. W. Milne
Western Advertising Manager
7530 Sheridan Road
Chicago 26, Illinois
Tel.: AMbassador 2-7091

A. J. Underwood
Midwestern Advertising Manager
3-210 General Motors Building
Detroit 2, Michigan
Tel.: TRinity 2-0606

SAE DETROIT OFFICE
R. C. Sackett, Staff Representative
808 New Center Bldg.
Tel.: TRinity 5-7495

SAE WESTERN BRANCH OFFICE
E. W. Rentz, Jr.
West Coast Manager
Petroleum Bldg.
714 West Olympic Blvd.
Los Angeles 15, Calif.
Tel.: Prospect 6559

Please address all editorial, advertising, and SAE Special Publications mail to:
29 West 39 Street
New York 18, N. Y.

1905 GOLDEN ANNIVERSARY 1955

Contents—October, 1955

Chrysler's Die-Cast Aluminum Torque Converter Housings—F. R. HOLLIDAY 17
Manufacturing Research—JOHN BERGMAN 20
Preventive Maintenance Programs—L. D. CONYERS 21
The New Packard Torsion Level Suspension—F. R. McFARLAND 22
Small Turbojet Engines—A. T. GREGORY 26
Dart Turboprop Engine—AIR COMMODORE E. R. PEARCE 27
Buick Switches the Pitch—R. J. GORSKY 28
Designing for a Specific Mission—R. P. BUSCHMANN 30
Diesel Injection Via Improved Distributor-Type Pump—S. E. MILLER and T. D. HESS 33
Radioisotopes—A. M. SMITH 37
How to Make Production Planning Work for You—R. J. HOHENFELDT 38
The Jet Stream: Sky-High Overdrive—ROBERT D. ROCHE 40
Rubber's Tendency to Crack Is Unpredictable—HERBERT A. WINKELMANN 44
"To Unite People—On That Depends the Destiny of Our Age"—BRIAN G. ROBBINS 47
Two Designs of Tubeless Truck Tires—C. R. CASE, T. A. ROBERTSON, and R. P. POWERS 48
Blast Cleaning—J. H. JONES 54
Measuring Combustion Chamber Volume—G. A. WEINERT 55
Automatic Transmissions—WALTER J. CROCKET, M. S. HANNA, and G. H. MAXWELL 59
Bringing Dream Cars to Reality—J. W. SHANK 60
Specific Suggestions for More Effective Quality Control—H. D. BIRCH, and F. J. HAHN 62
1955 SAE Beecroft Memorial Lecture—D. GRANT MICKLE 64
Cornering Force—J. J. ROBSON 73
Report of 1955 SAE Golden Anniversary West Coast Meeting 74

■

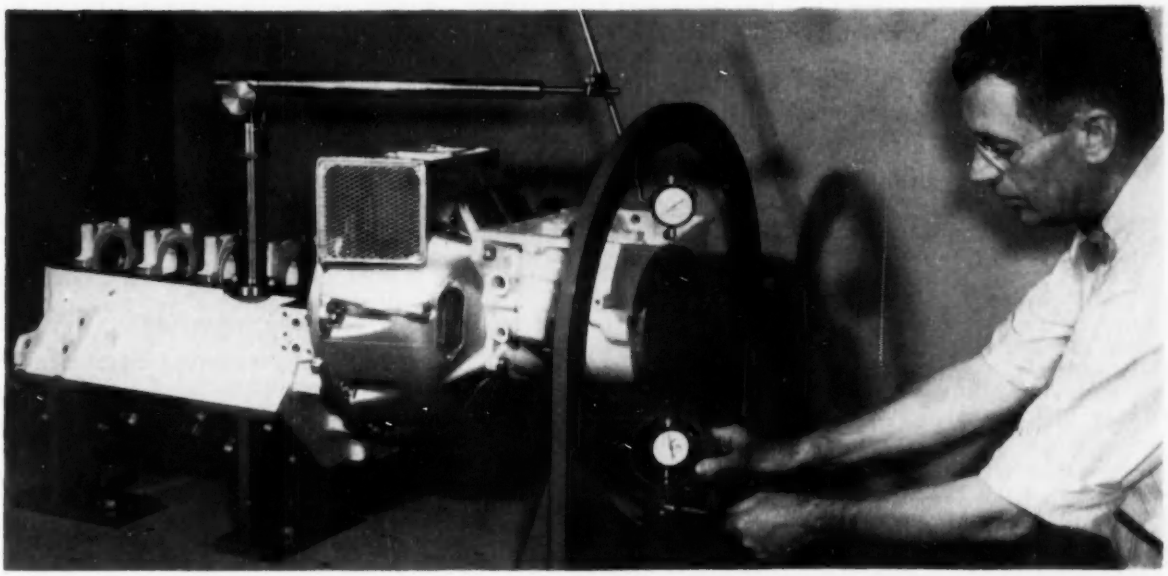
SAE Section Meetings 79
About SAE Members 82
News of SAE 86
National Meetings Schedule 86
Announcement of 1955 SAE Golden Anniversary Transportation Meeting 87
Announcement of 1955 SAE Golden Anniversary Diesel Engine Meeting 88
Section Meetings Schedule 89
You'll Be Interested to Know 89
Announcement of 1955 SAE Golden Anniversary Fuels and Lubricants Meeting 90
Technical Digests 102
New Members Qualified 126
Applications Received 127

Society of Automotive Engineers, Inc.

C. G. A. Rosen
President

John A. C. Warner — **Secretary and Gen. Manager**

B. B. Bachman — **Treasurer**



CHRYSLER'S DIE CAST ALUMINUM TORQUE CONVERTER HOUSING IS TESTED FOR STRESS AND RIGIDITY.

Stress tests helped design

Chrysler's Die-Cast Aluminum Torque Converter Housings

F. R. Holliday, Chrysler Corp.

Based on paper "Chrysler Die Cast Aluminum Torque Converter Housings" presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 16, 1955.

CHRYSLER's die-cast aluminum torque converter housings were developed from designs based on extensive experimental stress analysis tests. Prototype models were tested for strength and rigidity and modifications made in design accordingly. This method reduced development time considerably and produced a low-cost, light-weight housing that is encouraging the use of light metal die castings for other automobile parts.

Experimental stress analysis was used as a quick way to determine if the material in the housing casting was properly distributed and to indicate where design revisions were necessary to keep stresses within allowable limits. The needed modifications were usually clearly evident; so, much trial and error was avoided.

First, a stress revealing brittle lacquer was applied to all regions that could be inspected visually. Since this coating becomes brittle upon drying, it cracked when the surface elongated. Stress patterns first appeared in the lacquer at the regions of maximum stress, so that by gradually increasing the test load, regions of stress concentration became evident and stress distribution was revealed. By placing electric strain gages normal to the direction of the lacquer cracks, as shown in Fig. 1, we obtained accurate knowledge of stress magnitudes at each gage location.

The usual test procedure followed while evaluating a housing is as follows:

(1) Measure the deflection at the load point for vertical and horizontal loads in two directions.

CONTINUED ON NEXT PAGE

(2) Lacquer the parts and produce stress patterns.

(3) Install strain gages and make static stress measurements.

(4) Transmit test results to the design department and suggest modifications.

(5) Re-evaluate modified parts.

This procedure allowed design modifications to be made quickly because members of the design group were often present while the tests were conducted.

For example, the rigidity of the converter housing was improved by design modifications which were seen necessary from the test results shown in Fig. 2. Dial indicator measurements of the application of static bending loads near the transmission front flange indicated definite bends in the deflection traverse in the adapter plate-converter housing front flange region, and at the clutch housing front flange. Although the bends in the curves were still apparent for the revised production design, the displacement was not as great and the total deflection at the load point was reduced 50% to 0.010 in. from 0.020 in. The improvement in rigidity was a direct result of the following design revisions:

Fig. 1—Lacquer pattern shows areas of stress. Electric strain gages normal to the lacquer cracks measure magnitude.

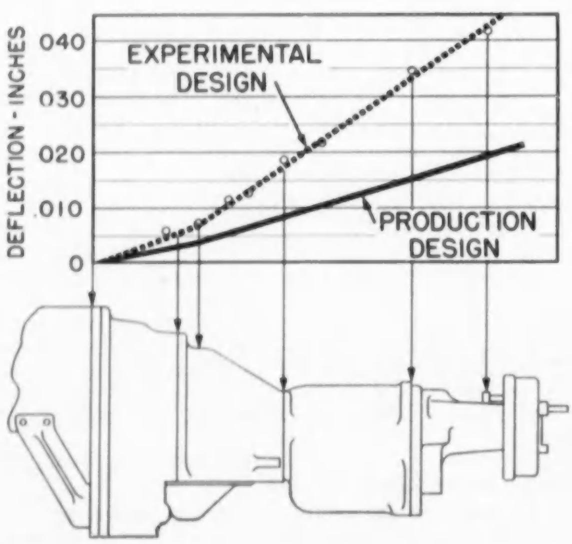


Fig. 2—Rigidity (measured in inches deflection) was considerably improved by design changes pointed out by dynamic deflection tests.

(1) Adapter plate was changed from 5/16-in. thick steel to ¾-in. thick cast iron.

(2) Brace design was improved and a rib was added to increase rigidity of the engine block flange at the brace attachment.

(3) Housing wall sections were straightened to eliminate local bending.

(4) Bolt bosses on both the converter and clutch housing front flanges were constructed better.

(5) Air outlet hose in the converter housing was made smaller.

As a matter of information, magnesium housings were used for this test. Soon after production of the die-cast housings began, the material was changed to aluminum because of economic advantages.

Use of the ¾-in. cast-iron adapter plate provided a means for conveying pressurized engine oil from the oil galley in the block to the torque converter rear bearing. It should be noted that, although the rigidity of the assembly was doubled, the frequency was only about 1.4 times greater; since the frequency varies with the square root of the ratio of stiffness, divided by the mass of the transmission assembly supported by the housings. Effects of other design modifications follow:

Adapter Plate Design

Adapter plates are used between the engine blocks and converter housings for all installations. Besides closing up the front of the torque converter from dirt and stones, this part contributes to the strength and rigidity of the housing assembly. Not long after the cast-iron adapter plate was placed in production, the manufacturing department expressed a desire to change the plate material to aluminum to facilitate machining and handling in the production plants. Laboratory evaluations indicated that the rigidity of the aluminum plates with wall convolutions as shown in Fig. 3 was com-

Fig. 3—Rigidity of aluminum plate (right) with wall convolutions was comparable, or superior to the relatively flat cast-iron plate (left).

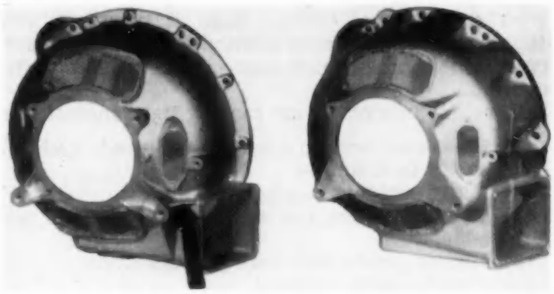


Fig. 4—Early air cooled converter housing design (left) was eventually modified to the stronger, more rigid design at right. A general design rule is to remove all ribs (as shown by the arrow).

Fig. 5—Present water-cooled converter (right) is great improvement over earlier design. Note the pocket type flange bolt boss construction. Conical shapes are stronger.

parable, or slightly superior, to the relatively flat cast-iron plate. The aluminum plate was released as a permanent-mold casting and has been used on all automatic transmission installations.

Converter Housing Design

The main considerations in housing wall designs were to use conical shapes instead of spherical contours, and to straighten the walls whenever possible for maximum structural efficiency. Presently, both water-cooled and air-cooled torque converter housings are being used for automatic transmissions. The design of the air-cooled housing is more difficult because of the greater wall offset required to clear the torque converter fins, and the air openings required for cooling as shown in Fig. 4. For the present housing designs, the reinforcing beads at the edges of the upper air inlets have been omitted, since no significant stress concentrations are present there. An example of the use of conical shapes is the starter pocket on the present water-cooled converter housing design shown in Fig. 5.

Although a general design rule is to eliminate all ribs, they have been found to be useful for increasing the rigidity for parts already in production. A good knowledge of the load direction should be available so that the ribs can be orientated along the principal stress axis. The use of double ribs at the front flange increased the bending rigidity in this region on one housing model which used a flange-type bolt boss, as shown in Fig. 6. The best solution to the flange bolt boss construction is the pocket-type boss used at the front flange of both the air-cooled and water-cooled housings. The stress concentrations inherent at the bolting flanges were reduced to very acceptable levels by this construction, which was also less difficult to cast than the ribbed design.

It is very necessary to evaluate designs and design changes on experimental castings since only minor changes can be made after the production dies are machined. Generally, the revisions possible at this time are limited to material additions on the casting by machining away material on the soft die, or by grinding after the die has been hardened. Some idea of the complexity of the problem involved in removing the large, heavy dies after they are installed in the die-casting machine, can be visual-

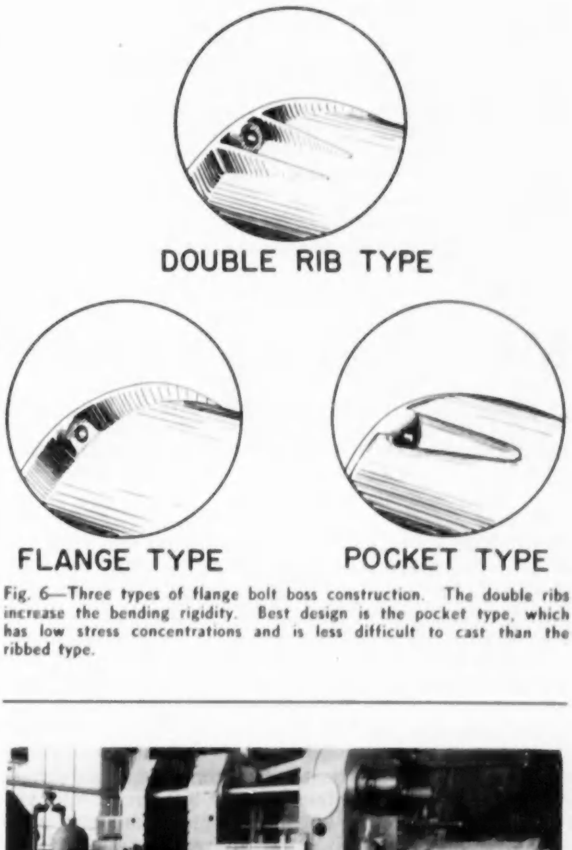


Fig. 6—Three types of flange bolt boss construction. The double ribs increase the bending rigidity. Best design is the pocket type, which has low stress concentrations and is less difficult to cast than the ribbed type.

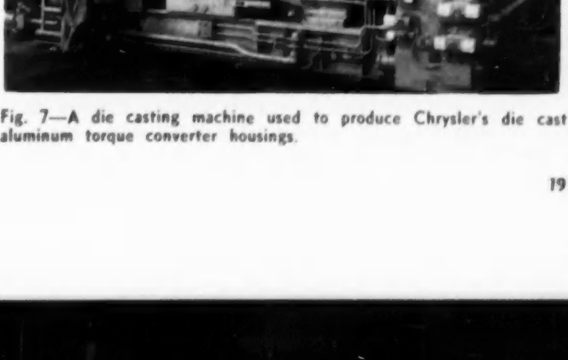


Fig. 7—A die casting machine used to produce Chrysler's die cast aluminum torque converter housings.

MECHANICAL PROPERTIES	LIGHT METALS		FERROUS METALS	
	DIE CAST ALUMINUM	DIE CAST MAGNESIUM	CAST IRON	MILD STEEL
STRENGTH ULTIMATE (1000 PSI)	35	29	30	47
STRENGTH FATIGUE (1000 PSI)	10	9	10	20
WEIGHT (LBS/CU IN)	098	065	261	285
STRENGTH-WEIGHT RATIO (10^5 UNITS) ULTIMATE	3.7	4.5	1.2	1.7
STRENGTH-WEIGHT RATIO (10^5 UNITS) FATIGUE	1.0	1.4	4	7
MODULUS OF ELASTICITY (10^6 PSI)	10.5	6.7	15	30
RIGIDITY-WEIGHT RATIO (10^7 PSI)	10.8	10.3	5.7	10.5

FATIGUE strength-weight ratios for light metals are considerably better than that of the heavier ferrous metals, and rigidity-weight ratios are comparable to that of mild steel.

ized from the size of the die-casting equipment used to produce the converter housings (Fig. 7). The best time for major design modifications on large parts such as torque converter housings is when the die must be replaced because of wear or deterioration, or when other design changes make the housing design obsolete.

Die casting was chosen as the method of production because walls can be cast thinner and with closer dimensional control than is practical with other production casting methods. Also, local reinforcements and heavier lugs can be added where required.

Other advantages of die casting light metals are:

(1) Less machining stock is required and it's easier to machine.
(2) Many surfaces can be cast to size.
(3) Greater degree and accuracy of coring is possible.
(4) Higher production rate per die cavity.
(5) Very smooth surfaces.
(6) Greater ability to reproduce complex shapes.
(7) Longer tool life.

One problem in die casting is that air is often trapped in the core areas causing porosity and weakening. But the soundness of the casting can be controlled by following these simple rules during the initial design which give better metal feed and solidification rates:

(1) Avoid heavy sections when possible.
(2) Use coring to the maximum extent—for example, all flange holes.
(3) Keep wall thickness to a minimum.
(4) Use generous bend radii.
(5) Use a minimum amount of finish stock for machined surfaces.
(6) Use as few ribs as possible.

(Paper on which this abridgment is based is available in full from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Manufacturing Research . . .

. . . becomes increasingly important. Development of new processes is leading to lower manufacturing costs, often to new products.

Based on secretary's report by **John Bergman,** General Electric Co.

INDUSTRIAL leaders have set up departments for manufacturing research with as carefully planned programs as those found in the fields of chemistry and physics. These programs are proving that research in manufacturing can pay dividends as well as research in engineering.

An example of manufacturing research that paid off is found in the Economic Cutting Speed Calculator developed by the Cincinnati Milling Machine Co.

In machining, the costs of loading, rapid advance, rapid return, and unloading for a given cycle are constant. As cutting speeds are increased, the total cost first decreases and then increases as speeds go up, because of the cost of changing and sharpening cutters for fewer work pieces. The point is to know the most economical cutting speed. With the calculator the cutting tool engineer can determine the breakeven point. Here, then, research provided more knowledge about cutting speeds, introduced a marketable item, and an item providing an advertising medium.

An example of research which paid dividends is the development of continuous horizontal surface broaching of blades by Tapco and Footburt. The production of 4,000,000 blades was deemed impractical on single-pass vertical broaching machines. But with the development of the No. 10 Footburt horizontal continuous conveyor chain blade broaching machine, 1560 pieces per hr could be produced in contrast with 240 pieces per hr on the vertical single-pass machine. In addition, semi-skilled women operators could replace skilled men.

Compressor blade manufacture provides another example of profitable manufacturing research. Robbins Engineering Co. had developed a basic process for producing jet engine compressor blades by a cammed milling cutter machining process which machined each side of the blade individually. There were four problems connected with the process:

1. A location problem of mismatch of one surface of the blade to the other.
2. A location problem of mismatch of either or both surfaces of the blade to the center-of-gravity point.
3. The process did not machine the trailing edges

of the blade, and it was necessary to radius these sections by hand.

4. The 500 to 600 microin. milled surface finish had to be polished to between 10 and 15 microin.

Four projects were launched but failed to solve the problems. Then it was decided to machine the entire airfoil section in one operation to remedy the first three problems, and to add a grinding operation to reduce polishing requirements. This was achieved by cutting hard, very accurate, 20-times size airfoil shapes for a number of stations along the blade. These were sandwiched between roughly shaped aluminum pieces, which were then carefully filed to blend with the exact airfoil shapes. The resulting master cam served as a pattern for production cams made on an Ex-Cell-O thread grinder. Production cams were used for milling or grinding.

Out of this project came two new machine tools with supporting equipment that became very marketable, and two plants for the manufacture of compressor blades in the U. S. A. and one in England.

(This article is based on the secretary's report of round table on "Manufacturing Research Programs Pay Dividends" held at the SAE Golden Anniversary Summer Meeting, Atlantic City, June 14, 1955. Leader of the Panel was K. W. Stalker, General Electric Co.; secretary was John W. Bergman, General Electric Co. Panel members were: C. P. Brooks, Austenal Laboratory, Howard Cole, Utica Drop Forge and Tool Co.; Joseph Crawford, Cincinnati Milling Machine Co., W. M. Williams, Thompson Products, Inc., and Louis Zimmel, Ex-Cell-O Corp.)

Preventive Maintenance Programs . . .

. . . can be simple. But it takes time and study to tailor one that will yield maximum returns for a particular operation.

Based on paper by **L. D. Conyers,** Consolidated Freightways, Inc.

FEW fleet operators have developed wholly satisfactory preventive maintenance programs. Some over-maintain—but unnecessary work cannot be justified by labelling it preventive. Others under-maintain—and suffer undue parts and labor cost plus the incalculable cost of down time.

A good system should have six objectives:

1. Lower operating cost.
2. Reduction of road failures.
3. Better oil and fuel mileage.
4. Longer vehicle and parts life.
5. Greater safety and better public relations.
6. Less interruption of service.

To obtain these objectives there are six basic practices to follow at regular intervals. These are: inspection, adjusting, tightening, lubricating, major overhaul, cleaning, and painting. The interval may be based on mileage, hours, or fuel consumed. Then, if the program is to be exact and efficient, consideration must be given to such factors as:

1. Routes traveled and road conditions.
2. Climatic conditions.
3. Gross loads.
4. Type, size, and power supply of vehicle.
5. Vehicle replacement procedures.
6. Life expectancy of vehicle and parts.

Preventive maintenance, then, means a scientifically designed program to keep all vehicles in the best possible condition by planning the bulk of "maintenance" work to be done on each vehicle at scheduled intervals, and "preventing" as far as possible the unnecessary parts and labor cost that would be incurred through neglect of small repairs.

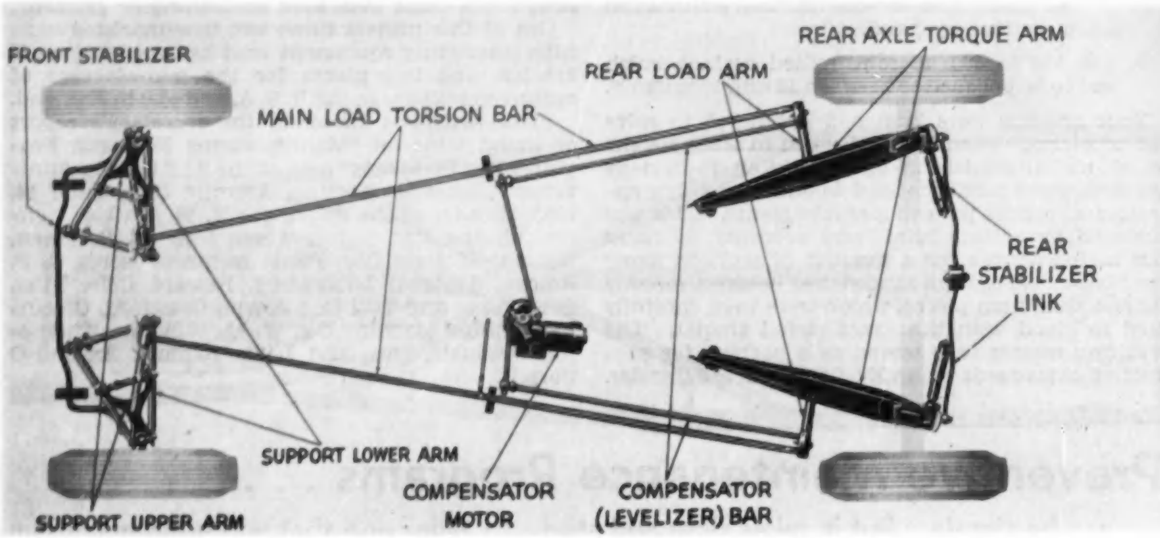
A satisfactory program need not be elaborate. A simple method should be developed for accumulating miles or time, preferably on a hard paper form which can be filed under the heading of the equipment it represents. There will also be needed an equipment record form, serving the dual purpose of determining service work due, and providing a permanent record of vehicle components. Then, one should develop a simple work sheet, or job ticket, the face of which will serve to indicate repairs needed, while the reverse side outlines the services and items to be inspected and lubricated, using a numerical or alphabetical system, or both, to designate services.

A few simple forms and mechanic's time cards will supply all that's needed for a labor cost accounting system. From this can be determined the labor cost per mile, or per hour of operation, and the man-hours per thousand miles or whatever hours are used as a yardstick.

Parts cost can also be kept on a simple card form bearing the equipment number or job number. As parts are issued from stock they can be appropriately charged. Part cost can then be entered on the card. As jobs are completed the forms should be filed under appropriate headings and kept as a record for the life of the vehicle. The cost of units can be handled in similar manner. However, they should not be charged out until they are issued for installation. It should be mandatory that all records be kept up to date.

Records of this type have many uses. They supply management with data relative to cost trends. They supply supervisors with the means for measuring their own efficiency, as well as that of mechanics, the lube, tire service, and parts men, office personnel, and even the shop clean-up man. Even the standards of shop operation can be set through them.

(Paper "Modern Approach to Preventive Maintenance" was presented at SAE Southern California Section, Los Angeles, April 11, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)



The New Packard Torsion

PACKARD's new torsion-level suspension combines a torsion bar suspension system with an automatic leveling adjustor. Although neither concept is new, Packard's system is unique in that the torsion bars connect the front and rear wheels. The automatic levelizer compensates for varied loads in the car and keeps the car level and stable.

Long torsion bars connect the front and rear wheels by suitable linkage that causes the car to ride level when passing over bumps and holes. These bars are the "springs" and are responsible for the unusually "soft" ride.

Short torsion bars connect the rear wheels to the frame. The adjusting mechanism attached to these bars keeps the car level at all times whether it is empty or has six passengers and over 300 lb of baggage. The bars also give stability to the vehicle.

The Torsion Bar Suspension

Two long bars run from the front to the rear of the vehicle. They are 111 in. long on the Packard car and have forged hexes at each end. The hexes fit into broached hex holes in levers mounted on needle bearings in brackets. Front brackets are attached to the front cross-member and rear brackets welded to the outside of the frame.

The front levers bear upon the lower A frames of the front suspension through struts shown in Fig. 1. The front suspension structure is the same as Packard's previous standard front suspension except for a change in the caster and camber adjustment and slightly looser fits in the threaded bushings to minimize friction.

The rear axle is held fore and aft against rotation by torque arms as shown in Fig. 2. The levers at the rear end of the long torsion bars are attached to the torque arms by the stirrups shown in Fig. 3. At the top and bottom ends of the stirrups are antifriction bearings.

The rear axle is held laterally by the stabilizer or tracking linkage construction shown in Fig. 4. The two links are fastened to the rear axle at the outer ends by rubber bushings. At their inner ends they are fastened to the equalizing lever by rubber bushings. This lever is mounted in rubber bushings to a bracket bolted to the rear channel. This construction allows vertical axle movement without feeding lateral movements into the rear of the frame, avoiding harshness. It also ties the axle to the frame as

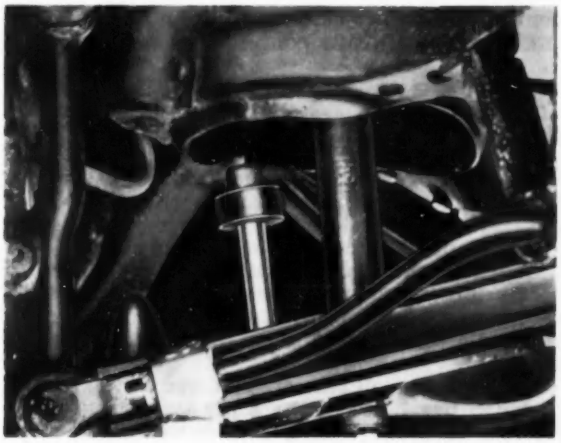


Fig. 1—Front suspension construction showing the front strut location. Struts come in four lengths which vary the standing height of the car in 3/8-in. increments.

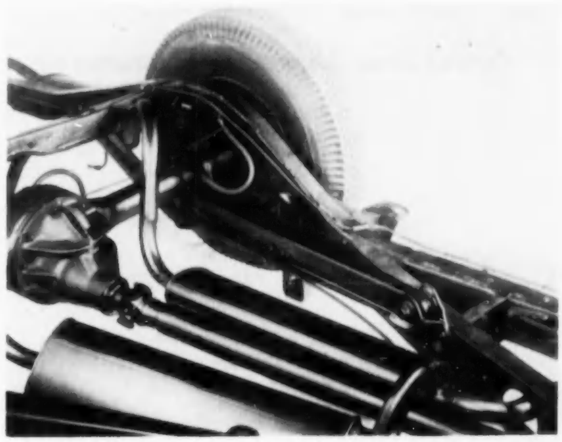


Fig. 2—Rear suspension construction showing the attachment of the rear axle to the frame. Torque arms prevent the rear axle from rotating.

Level Suspension

F. R. McFarland, Studebaker-Packard Corp.

Based on paper "The New Packard Torsion Level Suspension" presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 15, 1955.

an added safety feature for unusual operating conditions.

How It Works

When the front wheel hits a bump, the wheel rises, twisting the torsion bar by the front suspension linkage, causing an increase in the upward load at the torsion bar lever bracket attached to the front channel of the frame. The increase in twist in the bar causes the loading of the lever at the rear end of the bar to increase, thereby increasing the push of the rear wheel on the ground. The net reaction of the rear torsion bar lever and torque arm appears on the rear of the frame upwardly at the point of attachment of the rear lever. This increase in upward loading is simultaneous with the increase in upward loading at the front channel. The result of these two loads acts near the center of gravity of the car fore and aft and tends to lift the car without much pitch.

Since the inertia of the car in translation upward is high compared to its polar moment of inertia about a horizontal transverse axis in the vicinity of the center of gravity, and since the spring rates are only slightly over half those of conventional front and rear springs, the total upward thrust is approximately equal to that at the front of the car with a conventional suspension. Thus, the upward move-

Fig. 3—Stirrups attach the rear end of the torsion bars to the torque arms. At the top and bottom of the stirrups are anti-friction bearings.

Torsion Level Suspension Advantages

PACKARD feels that the torsion level suspension has the following advantages over the standard type:

1 **Flat ride.** There is less pitching, resulting in a more comfortable ride.

2 **Level ride.** Empty or full, the car is always level. Over-all height varies slightly more than 1 in.

3 **Soft ride.** Spring rates per wheel are only slightly more than half that of conventional designs, giving softer rides.

4 **Headlights** stay on the road.

5 **No rear end squat** on acceleration. Bottoming doesn't occur because of torque arm action.

6 **Less dive** on stopping. The torque arms' tendency to hold the rear end down helps lessen front end dive.

7 **Better wheel traction.**

8 **Less torsional stress** in the frame.

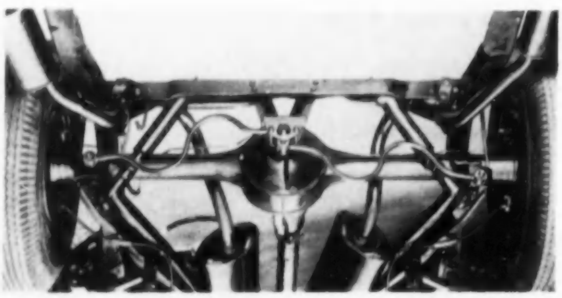


Fig. 4—Tracking or stabilizer links are fastened to the rear axle at the outer ends by rubber bushings.

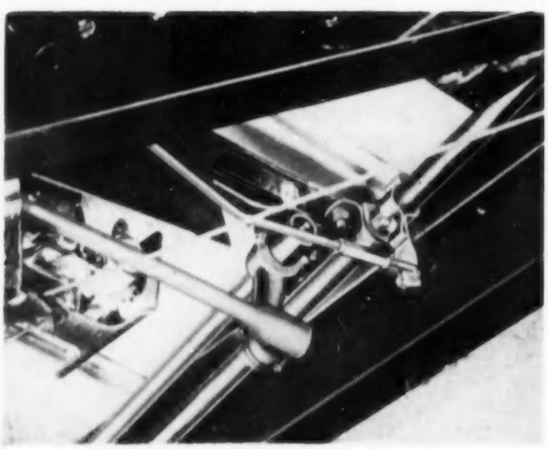


Fig. 5—Lever and linkage from the left main torsion bar leading to the compensator control switch.

ment of the car is small compared to the pitch occurring in a car with a conventional suspension.

The Compensating Mechanism

The functions of the compensator or levelizer are to keep the car level for all usual passenger loads and to furnish stability to the suspension.

The compensator consists of two short torsion bars attached to the rear axle linkage and frame, an electric motor, gear reduction and linkage for winding the bars in either direction to raise or lower the car, and a sensing means for telling when the car is not level.

The short torsion bars are clamped at the rear in broached hex holes in the same levers that carry the rear ends of the long torsion bars. The short bars at the front are clamped in hex holes in levers and located in brackets attached to the frame. Both left and right levers carry ball joints to which links are attached. These links in turn are attached to the ball joints on two arms of a central lever mounted on a shaft which is the output of a planetary and worm gear reduction of 2762 to 1. The worm is driven by an electric motor. A control switch is actuated by the sensing lever located on the long left torsion bar.

The operation in detail is as follows. The sensing lever is located at the node of the left bar at a "six o'clock" position as shown in Fig. 5. As long as the car is level even though its vertical height changes, the nodal point does not rotate, so the lever remains at six o'clock. If the rear of the car is low the lever moves to a position slightly earlier than six o'clock viewed from the rear. If the rear is high, the lever moves to a position slightly later than six. The moving lever on the long left bar then moves the lever in the control switch mounted on the front X-member of the frame. As soon as the car is out of level with the ground by approximately $\frac{5}{8}$ in. contact is made inside the control switch, shown diagrammatically in Fig. 6, which heats a bimetal element. After a 5 to 7 sec delay, the bimetal element closes a contact actuating a small relay that supplies current to the motor solenoid. The motor through the reduction gears and linkage winds the two short bars in the proper direction, bringing the car back to level. As soon as the car is level within $\frac{5}{8}$ in., the lever on the long torsion bar moving the lever on the control switch cuts off the current to the relay and solenoid, which stops the electric motor. The slight over-run of the motor brings the car close to the ideal position.

Operation of the compensator in the opposite direction is the same as described except the opposite leg of the bimetal switch is heated, causing the bimetal element to make contact with the switch operating the relay and solenoid that runs the motor in the reverse direction, thereby lowering the car.

Ambient temperature differences, however, act on both legs of the bimetal element, causing the unit to be substantially temperature insensitive with respect to the gaps between the points. Use of the bimetal element solved a troublesome problem of eliminating most of the variation in delay time due to temperature variation. A switch combined with the stop light switch opens the circuit to the com-

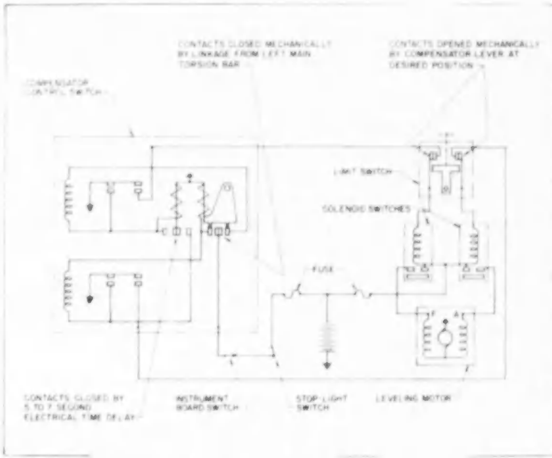


Fig. 6—Electric circuit diagram of the compensator mechanism.

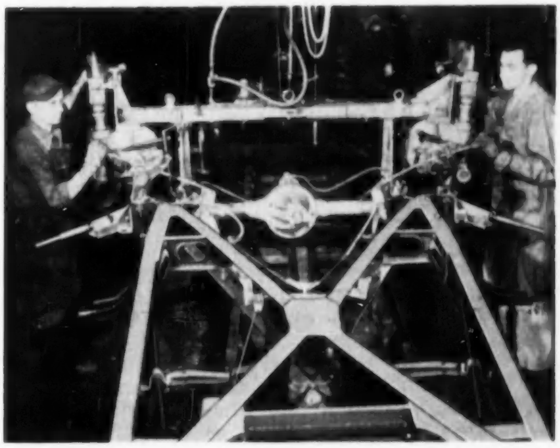


Fig. 7—A winding fixture was specially designed to wind up the torsion bars on the production line.

pensator controls when the brakes are applied, preventing compensator action during this operation.

Travel of the levers is controlled by limit switches which cut off the current supply when the levers have moved to their maximum desired positions. A dash switch also indicated in Fig. 6 is provided to cut out compensator action when changing tires. Within a few days after Packard mechanics had used this mechanism, they found that if two of them sat on the rear bumper, the compensator would raise the car to level. Then if they immediately turned off the compensator switch the rear of the car would be left in the air, thereby saving themselves considerable work jacking up the rear of the car to change rear tires.

Technical Details of Construction

The long torsion bars are made of SAE 5160 steel, 1-in. diameter, precision rolled, and upset at each end into hexagons without any further finishing. The hexes are straight. Considerable thought was given to crowning them or making the hex larger at its extreme end to "flow" the stress out of the bar more uniformly. To date no bars have broken at the hex ends, indicating the present method appears to be satisfactory. The bars are shotpeened and then pre-twisted 100% to index the hexes and pre-stress the outer fibers which further insures against breakage. The bars are stressed to a maximum of 130,000 psi during full simultaneous bottoming at front and rear wheels which rarely happens in service. This compares very favorably with the combined stresses on front coil springs of the majority of present cars under bottoming loads at the front wheels only, which would occur much more frequently.

Assembly of the long torsion bars in the chassis is one of the problems worked out with production during development. A winding fixture was designed (Fig. 7) to wind up the bars. The fixture consists of two air motors, each driving a gear reduction unit. The output shafts of the reduction units have pilots fitting into the broached holes in the rear levers carrying the hex ends of the long torsion bars, and driving arms that bear against the torsion bar levers. After assembling the fixture to

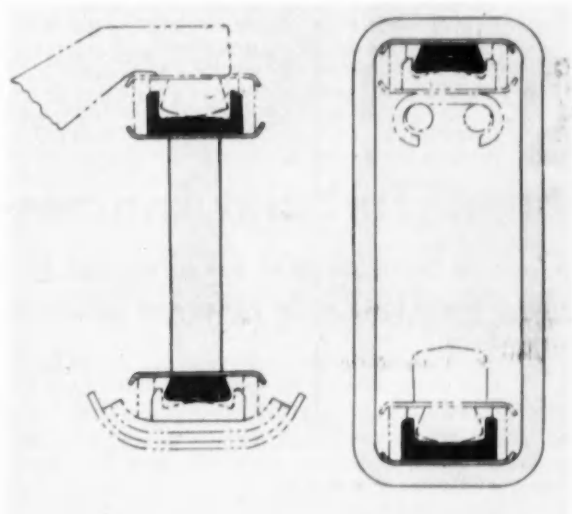


Fig. 8—Front struts and rear stirrups had to operate with minimum friction. The design finally developed (above) used bearings with a slight curvature which reduces the spread of the contacts and reduces friction.

the bar in the free state, the bar is twisted approximately 120 deg, the stirrup is dropped over the end of the lever, and the lever is backed up, seating the bearing end of the lever into the bearing in the stirrup. Production now states assembly of these bars is preferred to the assembly of the conventional coil and leaf springs.

The compensator bars are assembled with no load. These bars operate at comparatively low stress values but are shotpeened as an additional precaution.

One of the problems in the development of this system was how to minimize friction. The inner bearings of the front suspension structure and all

joints of the rear suspension structure are rubber. The torsion shaft levers operate on needle bearings. The bearings in the struts at front and stirrups at the rear had to operate substantially without friction. Various needle bearings, ball seats of bronze and nylon, and rubber arrangements were tried without success. The final design is shown in Fig. 8 for front and rear.

Individual wheel rates on the Packard car are 66 lb per in. front and 69 lb per in. rear. Ride rates are approximately 3 lb per in. less. When the front and rear wheels are deflected in equal amounts simultaneously, the front wheel rate is approximately 100 lb per in. and the rear wheel rate, 104 lb per in. Ride rates are approximately 7 lb per in. less. The front wheel and ride rates include 26 lb per in. due to the front suspension and stabilizer rubber bushings. The rear wheel and ride rates include 40 lb per in. due to the rates of the compensator bars and the torque arms and track linkage rubber bushings.

These rates contribute toward pitch but are low compared to the equivalent standard suspension rates, making the car relatively pitch free under most normal conditions. Pitch frequency is approximately 40 cpm and bounce frequency approximately 54 cpm for the Packard car with 4.5 passenger load.

Roll stability of the car is higher than that of our standard cars due to the location of the attachment points of the long torsion bar levers at the rear and the fact that the combined spring rates act on the body in roll.

The roll center is approximately on the ground surface at the front wheels and approximately 11.75 in. above the ground at the rear wheels.

(Paper on which this abridgment is based is available in full from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Discussion

R. H. Isbrandt,
American Motors Corp.

Packard deserves credit for attempting a different approach in the improvement of suspension systems. The attachment of the torsion bar to the linkage by upsetting the bar into a hexagonal shape has obvious merits over some previous designs. An exceedingly low wheel rate does not always produce a soft boulevard ride, and it appears that the damping of this suspension through the shock absorbers has been found necessary in order to approach accepted standards of stability and control.

Small Turbojet Engines . . .

. . . hold great promise for aviation. Their simplicity, reliability, and economy recommend them for a wide variety of applications.

Based on paper by **A. T. Gregory,** Fairchild Engine Div., Fairchild Engine and Airplane Corp.

EXPERIENCE with small turbojets in missiles and target drones reveals that these powerplants also possess advantages for manned aircraft. Their ratios of thrust to weight and thrust to frontal area are high, they are simple and economical to develop and build, and they are rugged and reliable for all types of operation.

The small turbojet probably will not achieve as low specific fuel consumption as the larger and more complicated engine, at least at low speeds, due to using lower pressure ratios. However, specific fuel consumptions at sea level static conditions are still expected to be well under 1 lb per lb thrust-hr. At high Mach numbers the fuel consumption may be as good as that of the large, complicated engine since the optimum pressure ratio falls with increasing Mach number. The small turbojet, therefore, may be ideally suited for use at supersonic speeds.

Reynolds number effects may be a problem, but they do not appear to be too serious for present maximum operating altitudes of turbojet engines. Insofar as weight varies as the cube of engine diameter and power as the square, the smaller engine will always be lighter per pound thrust. The smaller-diameter engine cannot be proportionately shorter since combustion chamber length has to remain substantially constant. Accessories are not proportionately smaller and materials are not proportionately thinner, so the cube/square law is probably more accurately a 5/4-power law.

Undoubtedly there are limits beyond which the law does not hold, but to predict those limits would be difficult and presumptuous. In general, the smaller the engine, the simpler it will have to be. The extent to which simplicity can be carried to maintain a thrust/weight advantage depends upon the ingenuity of many engineers. Thrust/weight ratios of over 10 to 1 are believed to be attainable in the future in engines meeting specifications for manned aircraft.

The location of accessories poses a big problem for designers of small turbojets. Mounting them in front of the compressor would make an engine unacceptable for supersonic flight. Placing them around the compressor casing in more or less conventional manner might increase engine frontal area to twice what it could be without accessories. We need smaller accessories, and great care is needed in locating them properly. Some will have to be located remote from the engine and driven from a long-shaft drive or a separate power source such as a hydraulic drive or a small air turbine.

The latter arrangement appears attractive for multi-engine or cluster installations. Air might be bled from each engine into a header pipe to the air turbine. The higher the air temperature, the

greater the engine efficiency. If one engine is provided with an electric starter, the rest could be started by impingement of the air from the header onto each turbine wheel.

Powerplants for a given size airplane might be developed and produced at lower cost as small turbojets. In the first place, the engines would be simpler than large engines. The size and cost of the experimental test and research facilities is much smaller than those required for large engines. Similarly, the size and cost of machine tools and production facilities is smaller.

Use of multiple engines instead of one large one would permit efficient operation of an aircraft over a wide range of Mach numbers since the number of engines in operation could be varied. With such operation, off-design-point performance would not be as serious a problem as with a single large engine. As a result, we might expect improved fuel economy and greater airplane range.

(Paper "Small Turbojet Engines—A Big Factor in Aviation" was presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 18, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Dart Turboprop Engine . . .

. . . introduces new overhaul problems, but they are simple enough to be handled by existing personnel at regular airline bases.

Based on paper by **Air Commodore E. R. Pearce,** Rolls-Royce of Canada, Ltd.

ON the Rolls-Royce Dart engine there are seven combustion chambers. (Fig. 1 shows the components of a chamber assembly.) At take-off power each chamber has an airflow of about 3 lb of air per sec, and burns fuel at the rate of about 20 gal per hr.

The flame tube which encloses the combustion zone operates at a high temperature and ultimately shows the effects of it. The three flame tubes shown in Fig. 2 were selected to illustrate what sometimes happens in the course of some hundreds of hours of operation. The severe distortion visible in the middle zone represents the region of highest temperature.

Much salvage work can be done on flame tubes in this state by heating out distortion, welding up cracks, cutting out damaged areas and welding in patches, or even inserting new sections. Such soling and heeling is worthwhile because the tube is fabricated from expensive heat-resisting material. However, the work is similar to that with which a sheet metal shop is familiar.

Since the discs and blades of the turbine rotor assembly are subject to relatively high centrifugal stresses while the blades work at fairly high temperatures, there is a special problem of inspection. Here, again, the solution is simple since both discs and blades can be removed very easily for inspection.

(Paper "The Rolls-Royce Dart Engine" was presented at SAE Montreal Section, Nov. 15, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Fig. 1—These are the components of a Dart turboprop combustion chamber assembly. The flame tube which encloses the combustion zone takes the brunt of high temperatures.

Fig. 2—Distortion of the flame tube is easily seen in the middle section of these three examples. Much salvage can be done by methods familiar to sheet metal shops.

Buick Switches the Pitch . . .

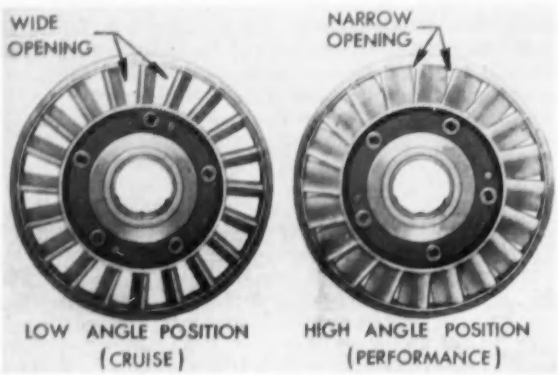


Fig. 1—Stator vane openings can be changed for best performance under different driving conditions. Wide openings (left) are for cruising, narrow openings (right) are for full throttle performance.

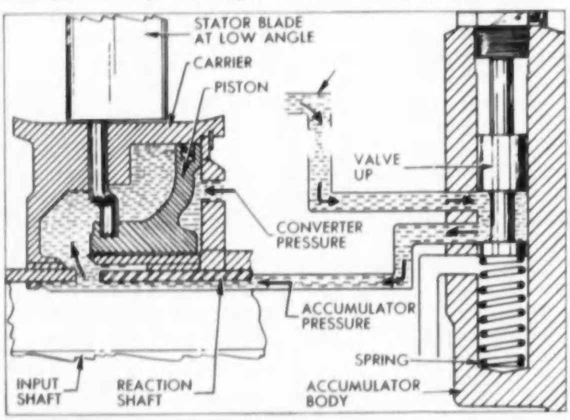


Fig. 2—Stator vanes are actuated by cranks in the stator vane assemblies. Control valve, operated mechanically from the throttle, directs oil to the stator piston which pivots the vanes from high to low pitch.

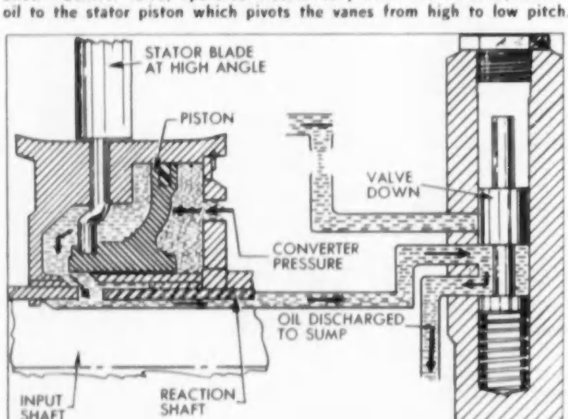


Fig. 3—When control valve is depressed oil is discharged to sump and stator piston pushes against the vane crank and changes the blade to a high angle.

BUICK's Dynaflow Transmission was redesigned for 1955 to use variable pitch stator vanes instead of fixed stator vanes. The vanes are pivoted so that the driver can adjust the converter to meet driving conditions. Manufacturing the blades presented many problems which were eventually solved to allow high production at reasonable cost.

Blade angle is variable

During normal acceleration and cruising, the stator vanes are at "low angle" or nearly parallel to the centerline of the converter. This gives the largest openings between the blades, allowing the oil to move freely with a minimum amount of redirecting. At "low angle", engine speed is less and converter operation is more efficient than at "high angle."

During full throttle operation, the stator vanes are at "high angle"—like a venetian blind partially closed. (See Fig. 1). This redirects the converter oil flow more and gives a higher converter torque ratio. It also permits the engine speed to increase so that the engine can develop more power to feed into the converter.

The stator vanes are actuated through cranks in the stator vane assemblies. These cranks fit into a groove in the stator piston, which moves in response to oil directed from the stator control valve. (See Figs. 2 and 3). The control valve is operated mechanically by linkage from the throttle control mechanism. This linkage is so arranged that full throttle opening of the engine can be obtained before the stator vanes pivot from low angle to high angle. An adjustment is provided to enable this change to be made somewhat short of full throttle opening if desired. An added resistance at the end of the throttle pedal movement is used so that the driver will realize that further movement will put the transmission into performance range.

The transition from cruise performance to full throttle performance is very smooth, because it is accomplished by changing the converter fluid flow instead of by shifting clutches and bands. The effect on performance from low vane angle to high vane angle is greatest at low car speeds and gradually diminishes as the converter coupling range is approached at approximately 60 mph.

How blades were made

One of the problems of the variable pitch stator was to arrive at a design which would provide the greatest benefit to car performance, and still could be manufactured on a high production basis at a reasonable cost. This was accomplished in the following manner:

The stator blade carrier assembly is composed of two sections made of shell molded cast iron. These sections are partially machined, dowelled, and

. . . of its Dynaflow Transmission stator vanes

to give better efficiency at all speeds.

R. J. Gorsky, Buick Motor Division, GMC

Based on paper "Buick's Variable Pitch" presented at the SAE Golden Anniversary Summer Meeting, Atlantic City, June 16, 1955.

bolted together before they are finish-machined as an assembly. This provides castings with minimum weight, sound wall sections, and a coefficient of expansion nearly the same as the steel shaft upon which it is mounted. Close-fitting, steel-backed, bronze bushings are used at this location, which omits the necessity of cast-iron oil sealing rings. These castings are machined all over, removing 0.030–0.045 in. for rough cuts and 0.015–0.020 in. for finish cuts. Weight of these two castings is decreased 38% during machining. This can be compared to the 54% weight decrease of the sand-cast high-clutch drum during machining. The premium price paid for the shell molded castings is more than offset by the savings in machining.

The stator crank holes are drilled and reamed to a tolerance of 0.002 in. and their centerline is on the parting line of the two carrier sections. A close hole tolerance is required to minimize oil leakage past the crank bearings and the centerline parting permits the usage of a crank and blade sub-assembly.

Five flat head clutch recess machine screws are used to fasten the two carrier sections together. These screws are made of SAE 1010 or 1020 steel so that the clutch recess can be cold-formed. Trouble was encountered with production power wrenches turning in the recess, when a torque of 10 ft-lb was applied to this ¼-20 screw. This difficulty was overcome by carburizing, hardening, and drawing this steel to increase its strength and to retain sufficient ductility.

The stator piston or crank actuator is a sintered powdered iron part. Labyrinth grooves are machined on the ID to provide oil sealing, and a groove is turned on the OD to accommodate a cast iron seal ring. The weight decrease of this part during machining amounts to only 23%.

The outer ring or shroud is a sheet metal stamping. First, a cup is formed from which the bottom and draw flange is trimmed off, leaving a cylinder of seamless tubing. The cylinder is then fit over a plug and pressed axially between form controlling dies. This causes the center section to first bulge out, and then get squeezed together forming a very rigid "T" section. The holes which accommodate the outer ends of the cranks are pierced in a radial outward direction so that a smooth surface will be retained on the ID for the stator blade to seat against. No machining is done on this part. A die casting was initially considered for this part until a cost analysis showed it to be approximately three times as expensive.

The stator blade crank is made from close diameter tolerance SAE 1018 cold drawn wire of 0.1540–0.1550 in. diameter. This wire is fed in to a stop in a four slide machine. One slide forms the crank-throw, another squeezes the crank to reduce its thickness, and the part is cut off by the fourth slide. A section of the OD which presses into the stator blade, is serrated by cold rolling between knurling dies so that it will lock the crank into the blade against radial and axial movement. These knurled serrations must be parallel to the centerline of the part so that a uniform positioning of the crank to the blade can be maintained. Any error from zero lead will cause the crank to twist as it is pressed into place. If it is restrained from twisting, the serrations will shear metal from the hole in the blade. The part is then heat-treated to increase its strength and wear resistance.

Several types of blades, including sintered powdered iron, die cast, steel stamped, and extruded aluminum were considered. They all had their shortcomings in cost, durability, lack of uniformity, and performance characteristics. A smooth surface, free of irregularities, such as parting line flash, a thin trailing end, and practically no variation from part to part were required. A hot aluminum extrusion, cold drawn to maintain uniformity, filled the requirements the best. The cross section of this extrusion is being maintained within 0.002 in. of the exact contour shown on the drawing. The drawing is dimensioned in this manner so that tolerances from the tangent radius and chord dimensions cannot be accumulated.

The stator blades are cut from these hot extruded-cold drawn bars. The ends are broached to form a small thrust area and to a length of 1.061 to 0.001 in. The crank hole is drilled and reamed. This was the most difficult operation in making this part. Twenty blades are used per transmission. That's 63,000 parts per day. (Complete paper on which this abridgment is based is available from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Effectiveness, not performance, is the goal of aircraft designers today. They keep costs down by . . .

Designing for

THE big problem today is not how to design the best possible aircraft, but what kind of an aircraft should we design to accomplish a specific purpose. This requires an operations study of both technical and economic factors.

For military aircraft the goal is maximum combat effectiveness for the least cost; for civil aircraft the goal is more profit per investment dollar. In choosing the "most appropriate" rather than the "best performing" aircraft from many possible designs, both the military and commercial airlines can use similar operations research techniques.

Military – More Bang Per Buck

Suppose our over-all military objective is to be able to bomb certain enemy targets such as industrial centers. We must design an airplane that can do the most damage at the least cost to us, or as Lockheed puts it: more bang per buck.

Of course, this presupposes that the over-all military objective is a sound one. Perhaps the destruction of enemy industry will not be a deciding factor in winning a war. If so, then a perfectly designed bomber will not be a deciding factor. For a parallel example, we could now design a better torpedo-bomber than we had in World War II. But we do not consider torpedo-bombing an important mission anymore. Therefore, it would be a waste of time and money to build the best torpedo-bomber.

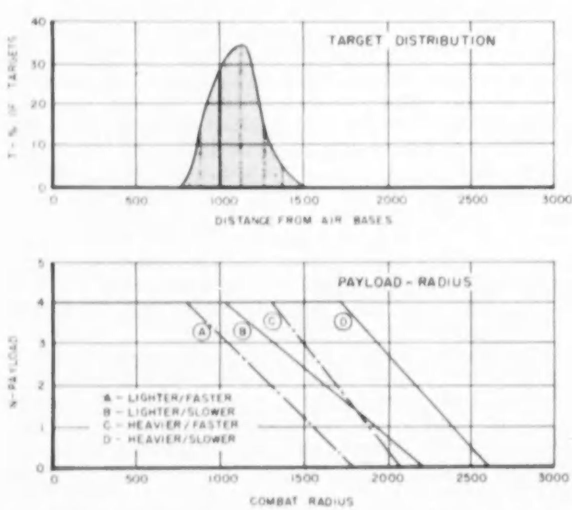


Fig. 1—(Top) Distance of enemy targets from our air bases is plotted. Approximately 30% are located 1000 miles away. (Bottom) Four different airplanes have different payload-combat range characteristics.

But assuming that the industry-bombing objective is correct, we can start our operations analysis.

First we consult a map and locate the targets of interest, as well as the air bases from which we expect to operate. We can now plot the target distribution as a function of the distances from the air bases, as shown at the top of Fig. 1. In this arbitrary example 30% of the targets which we wish to hit are located 1000 miles, and 15% of the targets 1250 miles, from our air bases. To accomplish our mission we can choose from many different types of aircraft. Let us simplify the problem and determine the best airplane from four arbitrarily selected planes. They are all different from each other in speed and range, but for this example we assume that all airplanes have the same payload space limit.

The four airplanes under consideration have the payload-combat range characteristics as shown at the bottom of Fig. 1. It is assumed that airplanes A and B have one common take-off weight, labelled "lighter"; and airplanes C and D have another common take-off weight, labelled "heavier." Furthermore, it is assumed that airplanes A and C have identical speeds, labelled "faster," and B and D have a different set of identical speeds, labelled "slower." A reasonable simplification for this illustrative problem is to consider the cost of the entire operation proportional to airplane take-off weights (Fig. 2, top).

Let us examine the load-carrying abilities of these four airplanes on the basis of their range, payload, and cost characteristics, but ignoring for the moment target distribution and combat attrition. The lower diagram of Fig. 2 shows the number of weapons carried per unit cost (N/C) as a function of combat radius. It is indicated, for instance, that attacking forces equipped with airplane C can carry 400 weapons per unit cost to a target located 1500 miles from air bases.

It is now necessary to combine these load-carrying abilities with the geographic requirements—that is, the target distribution, T, as a function of distances from air bases. The target distribution fac-

R. P. Buschmann, Lockheed Aircraft Corp

Based on paper "Planning For The Best Airplanes" presented at the SAE Golden Anniversary Annual Meeting, Detroit, Mich., Jan. 11, 1955

A Specific Mission

tor, T, is essentially a weight factor for the weapons carried per unit cost. The larger that T is for a certain distance, the more important it is to have a high (N/C) for this same distance. The curves resulting from the products of $T \times (N/C)$ are shown in Fig. 3. Also given in this graph are the integrations of these curves. Airplane B is better than airplane A by approximately 20% and better than airplanes C and D by approximately 40%.

These relative standings are indicated by the set of bars on the left hand side of Fig. 4. Let us now suppose that combat attrition decreases with increase in airplane speed. We assume that the higher speed airplanes (A and C) have a probability of being shot down by the enemy of 5% per sortie, and the slower airplanes of 8% per sortie. This means that the faster airplanes will fly an average of 20 sorties and the slower airplanes an average of 12.5 sorties during their combat life. The airplane costs must then be amortized over these respective lives. Stating it differently, the integrations of $T \times (N/C)$ must be multiplied by the respective kill probabilities. These results are shown as the set of bars at the right of Figure 4. It is shown here that airplane A is the best of the four airplanes considered on the basis of weapons delivered per unit cost, target distribution, and combat attrition.

This example has been quite limited. Only a few of the parameters which enter into an aircraft systems analysis have been included. We should consider many additional parameters: different types of powerplants, altitudes of operations, various sizes of maximum payloads, non-combat attrition of airplanes, airplane sortie rates, weapons destructiveness and hit probabilities, airplant abort probabilities, enemy defense effort, effect of enemy attacks on our own bases, base costs, various other base locations, and numerous other factors. All these parameters must be combined into one analytical expression and reliable quantitative data must be obtained for each of these parameters.

It may be that an operations research study will want to keep one or two parameters—such as enemy ability to destroy our airplane bases, or enemy defensive capability—as variables right through to the end, resulting in two or four recommendations on the characteristics of the aircraft system. This is advisable to give the military planner a feel for the importance of specific parameters. It also gives him an opportunity to apply his judgment or knowledge of additional intelligence information obtained after completion of a study.

Commercial – More Dollars per Dollar

Military operations research techniques can also be used to advantage in the commercial airplane field. Usually commercial planes that have the lowest direct operating costs are selected for opera-

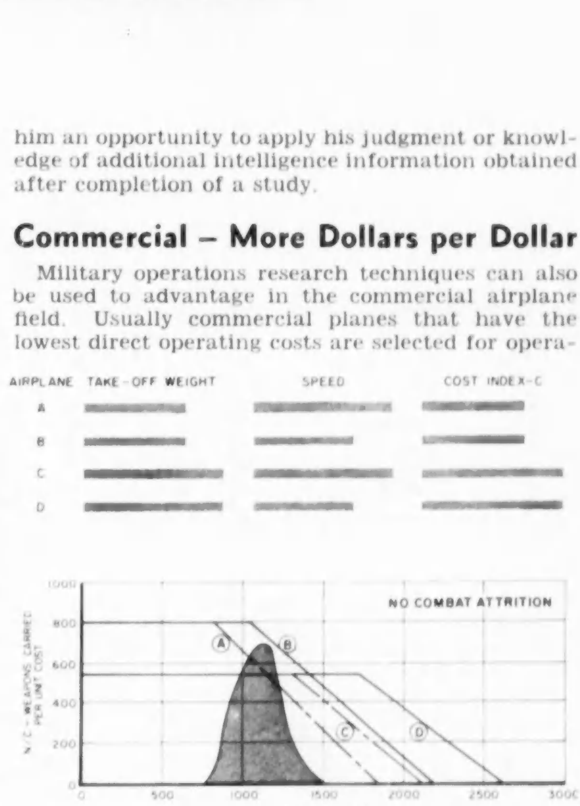


Fig. 2—(Top) For simplification, cost of the entire operation is considered proportional to airplane take-off weights. (Bottom) Number of weapons that can be carried per unit cost is plotted as a function of combat radius.

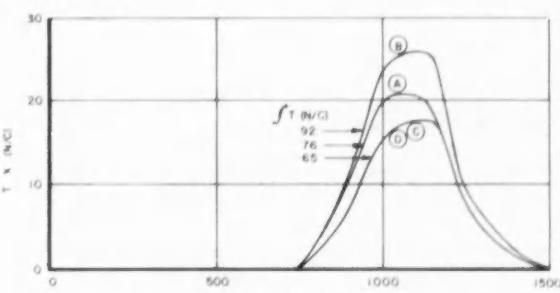


Fig. 3—Combining load-carrying ability with the target distribution shows that airplane B is better than airplane A by about 20% and better than airplanes C and D by about 40%.

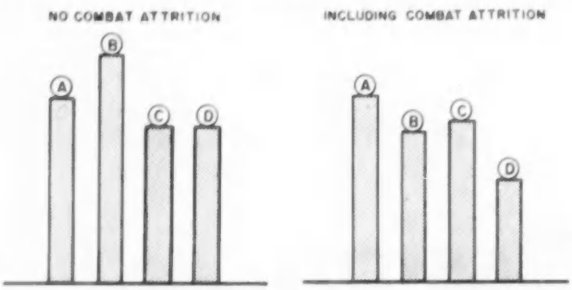


Fig. 4—(Left) The results of Fig. 3 are expressed as a bar graph. (Right) Assuming that combat attrition decreases with airplane speed, then airplane A is the best of the four on the basis of weapons delivered per unit cost, target distribution, and combat attrition.

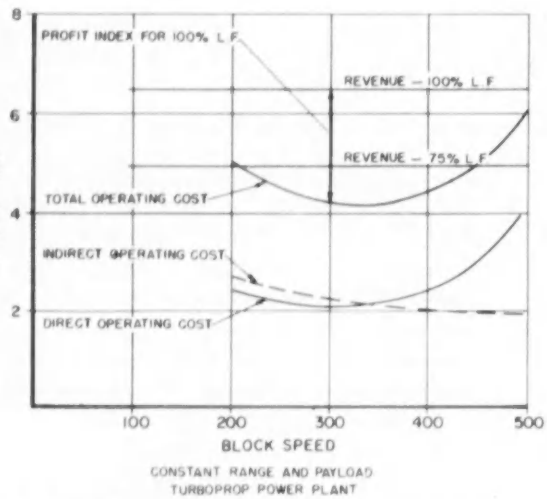


Fig. 5—Costs of a typical family of turboprop transport airplanes. All have same range and payload, but each was designed for different speed. Total operating cost is sum of indirect and direct operating costs.

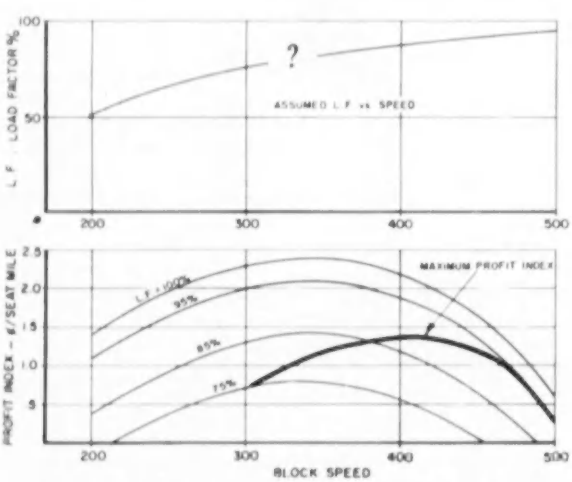


Fig. 6—(Top) The average load factor will increase with airplane speed because passengers will prefer to fly the fast airplane if price is the same. (Bottom) Combining load factor and cost index curves gives the profit index curve shown as a heavy line.

tions. Actually direct operating costs should be considered as only one of the factors in a transport systems analysis.

Fig. 5 shows direct operating costs (lower solid line) of a family of turboprop airplanes, all having the same range and payload but each designed for a different speed. Using direct cost as the measure of effectiveness we would conclude that an airplane should be designed with a speed of 300 mph. However, let us consider the effect of one additional parameter: indirect cost. Lockheed studies determined that indirect costs vary approximately as shown by the dashed line. The total operating cost is the sum of the direct and indirect costs. These costs are shown as the upper solid line indicating that the airplane should be designed for a cruise speed of approximately 340 mph, if we wish to achieve minimum total operating costs.

This, however, should still not be considered as the final answer. Let us assume that the airlines charge a passenger at a rate of 6.5¢ per mile. Then the profit index at 340 mph is 2.4¢ per seat mile, if the airplane is filled to capacity (100% load factor), and 0.8¢ per seat mile for a 75% load factor. The profit indexes for various load factors are shown in the lower diagram of Fig. 6 as a function of airplane speed.

We should also consider passenger appeal. If the airline charges a constant 6.5¢ per seat-mile then passengers will prefer to fly the faster airplanes, permitting the faster airplanes to operate at higher load factors. For this analysis an average load factor curve versus airplane speed, is shown in the upper diagram of Fig. 6. Combining load factor and cost index curves we arrive at a profit index curve shown as the heavy line in the lower diagram. The resulting optimum speed is 400 mph. This speed is 100 mph higher than would have been selected on the basis of direct operating cost (Fig. 7) and the potential profit for airplanes designed for 400 mph is twice that of airplanes designed for 300 mph. Consideration such as this will play an important role in the decision whether to build turboprop airplanes or the faster turbojet airplanes. (Paper on which this abridgement is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

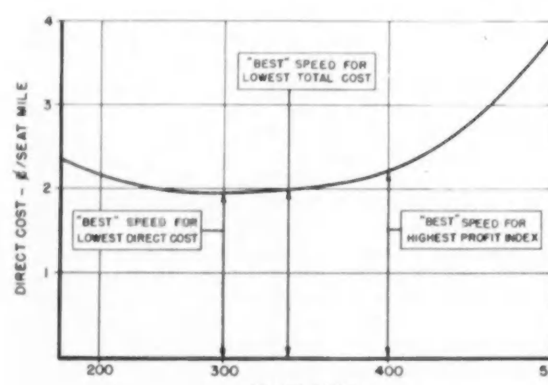
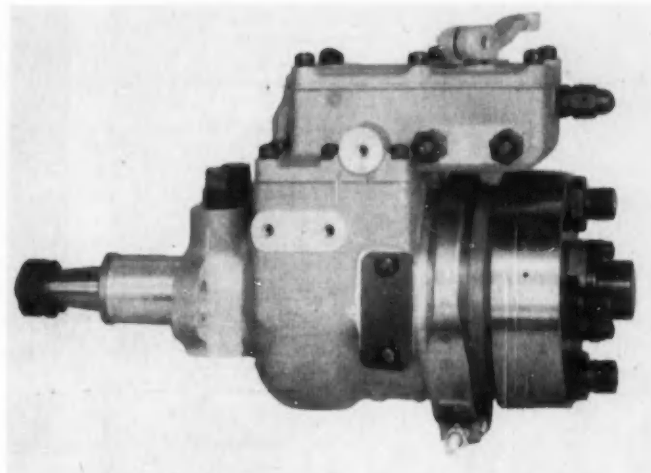


Fig. 7—Optimum speed (400 mph) for highest profit is 100 mph higher than would have been selected on the basis of direct operating cost.

Diesel Injection Via Improved Distributor-Type Pump



American Bosch (PDA) Diesel Fuel Injection Pump

American Bosch introduces low-cost, small-sized, distributor-type pump suitable for high-speed engines. Simplicity of design and flexibility in application are features of a new version of an old idea.

S. E. Miller and T. D. Hess
American Bosch Division, American Bosch Arma Corp.

Based on paper "A Diesel Injection System With New Features" presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 10, 1955.

USE of a distributor-type pump for diesel fuel injection has been limited in the past both by high cost and by lack of suitable building materials. Also, old-style pumps were applicable only to low-speed engines. Now American Bosch has overcome these difficulties with a new-model pump which features:

- Spill metering.
- A fuel excess of 100%, for starting.
- A torque-controlled governor.
- Choice of manual, fixed, or automatic timing.
- Choice of flange, base, or shank mounting.
- A screw-in nozzle holder.
- Adaptability to four-, six-, or eight-cylinder engines.

The basic characteristics of the modern fuel pump are:

1. Plungers accelerate before the beginning of injection.
2. Injection begins by closing a by-pass port.
3. Injection ends by uncovering a spill port.

The American Bosch double-plunger (PDA) pump retains these characteristics. It is designed to fit the small, high-speed engine.

Fig. 1 shows the pump cross-section. Some of the governor parts and the supply pump have been omitted in order to show the metering process more clearly.

In Fig. 1 the entire pump is filled with diesel fuel. This has been delivered from the final stage filter at a pressure of 5 to 10 psi. It lubricates all moving

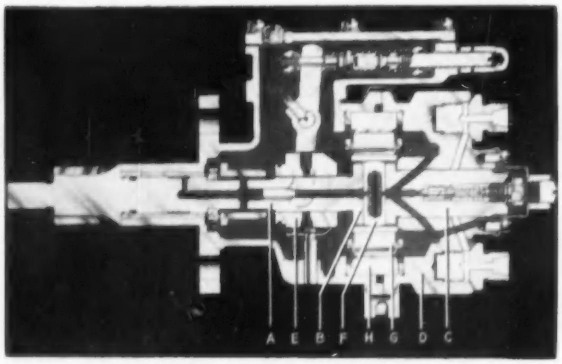


Fig. 1—Cross-section of new PDA pump; beginning of filling stroke.

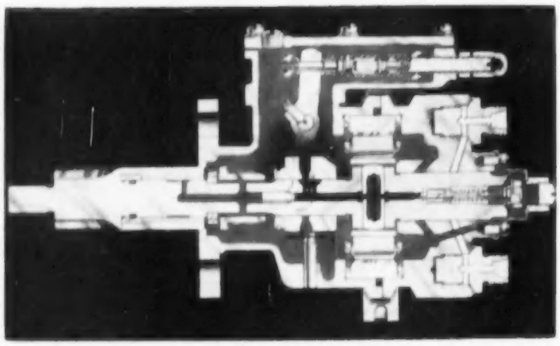


Fig. 2—Cross-section of new PDA pump; spill at beginning of injection stroke

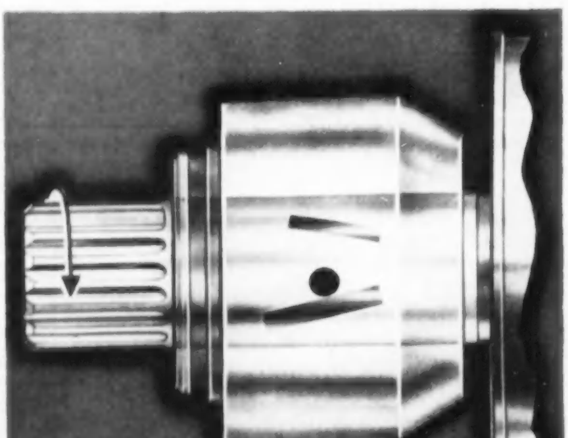


Fig. 3—Close-up of control-sleeve and shaft metering slots; round hole is in stationary sleeve whereas the two slots are in the rotating shaft. In above diagram, the larger slot has reached port closing and injection has just begun.

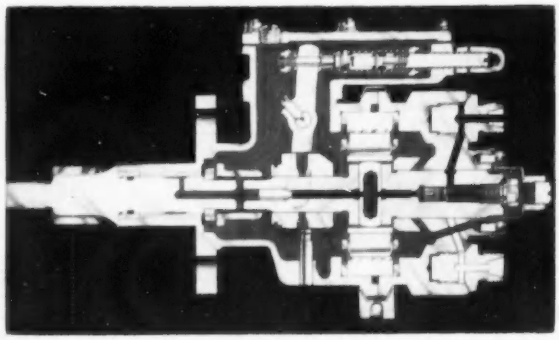


Fig. 4—Cross-section of new PDA pump; middle of injection stroke.

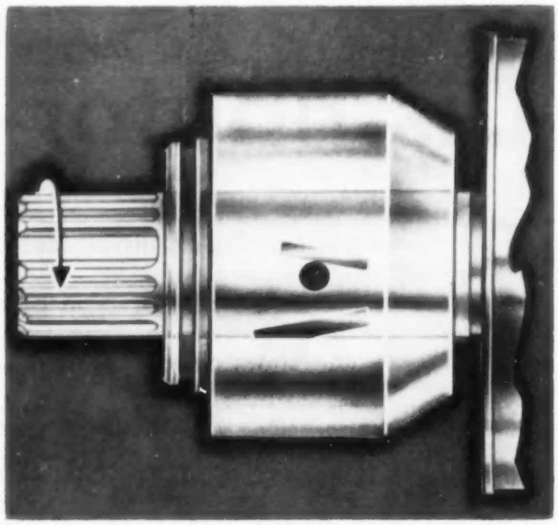


Fig. 5—Close-up of control-sleeve and shaft metering slots. Spill is about to occur.

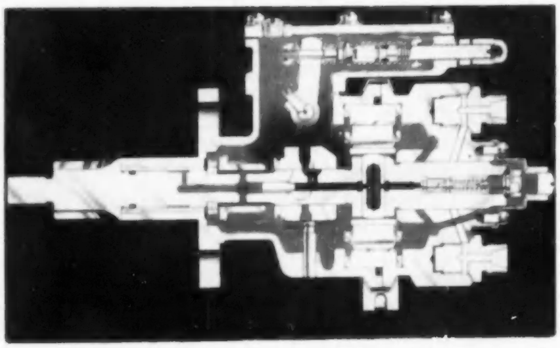


Fig. 6—Cross-section of new PDA pump; spill at end of injection stroke.

parts in the pump before being burned in the engine.

A rotor shaft comprised of a metering section (A), a pumping section (B), and a distributing section (C), rotates within a distributing head (D). Fitted to the metering section of the shaft is a control sleeve (E), which controls the metering and injection timing of the pump. The plungers (F), with their shoes and rollers turning with the rotor shaft, are forced into reciprocating motion by a symmetrical internal cam (H).

Spill Metering

In Fig. 1, the plungers are starting to move apart at the beginning of the filling stroke. Since the fill ports are open the entire time of the filling stroke, a gravity head of a few inches of fuel is usually enough pressure to assure complete filling.

When the plungers reach the end of the filling stroke the fill ports close. As the shaft rotates further, the plungers start moving toward each other to begin the injection stroke.

At this point in the cycle (Fig. 2) a roto-metering slot aligned with a sleeve port allows the fuel to spill back into the sump. Fig. 3 shows a close-up of the control sleeve and metering-slot arrangement.

Because of the angles of the shaft slots, the amount of fuel injected will be reduced, if the sleeve is moved to the right along its axis, or increased if the sleeve is moved to the left. Movements of the sleeve, therefore, control the amount of fuel injected. In addition, if the sleeve is rotated in either direction, a change in injection timing occurs without changing the metered quantity of fuel.

Fig. 4 illustrates the injection portion of the cycle. The fuel is distributed under pressure through one of the outlet tubing connections.

Fig. 5 shows the shaft-spill slot just being aligned with a sleeve port to allow spill to occur and end the injection.

Fig. 6 illustrates the end-of-injection spill.

Note that the pump is filled from a sump next to the distributing section of the shaft. Spill occurs in the governor portion of the shaft housing at the metering section of the shaft. Thus, the spilling of the fuel cannot appreciably disturb the filling operation.

Fuel Excess of 100%, For Starting

Fig. 7 shows the control sleeve and shaft metering slots in position for engine starting. Remember that if the metering sleeve is turned the pumping time will vary, since the port-closing and port-opening slots on the rotor shaft are at an angle with each other. Note that the port-opening slot is shorter than the port-closing slot.

Now if the sleeve is moved beyond full load to the position shown in Fig. 7, port closing will occur as before. As the shaft rotates, however, the shorter port-opening slot will not align with the sleeve port. Therefore no end spill will occur and the pump will continue the injection until the end of the plunger stroke. Pressure will be relieved at the end of this stroke by the opening of the fill ports. Excess fuel for starting is provided, therefore, simply by moving the sleeve to a point beyond full load.

The automatic control mechanism for excess fuel (described in the Torque-Controlled Governor section) is set to operate only in the speed range from 0 to 500 rpm.

The governor is a simple ball-and-single-cone type as shown in Fig. 8. In this design the governor cone is carried directly on the metering sleeve. Thus, no awkward connecting linkages exist between the governing and metering elements.

The governor cannot operate at speeds below 500 rpm. Above 500 rpm the governor is driven from the pump drive shaft through splined members (A). They in turn drive the ball cage through a shock-absorbing member (B). This member absorbs engine vibration.

Pushed by the ball cage, six balls (C) shove

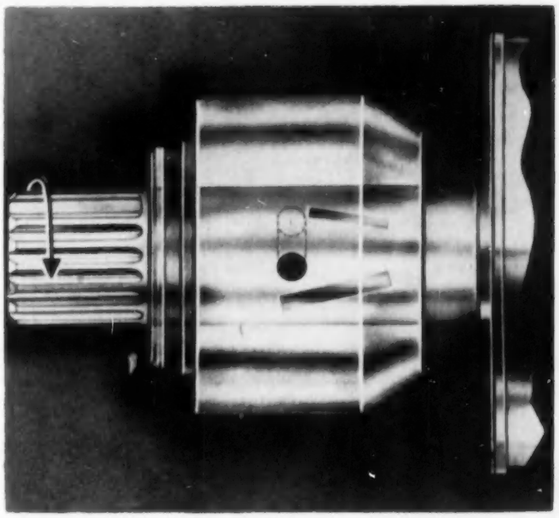


Fig. 7—Close-up of control-sleeve and shaft metering slots; fuel excess of 100% for starting.

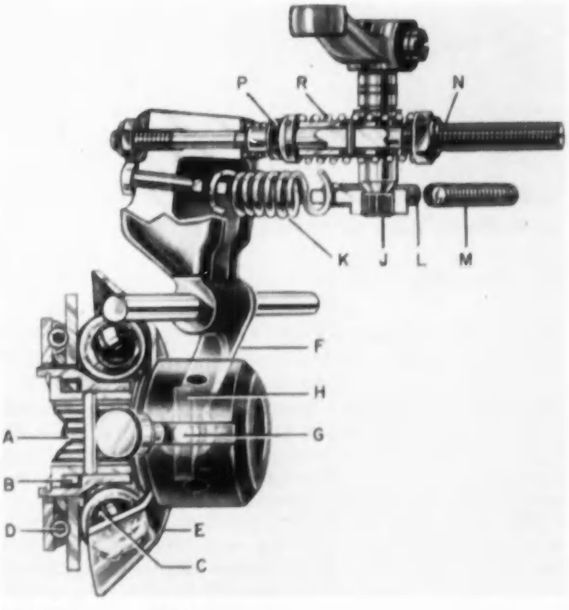


Fig. 8—Torque-controlled governor.

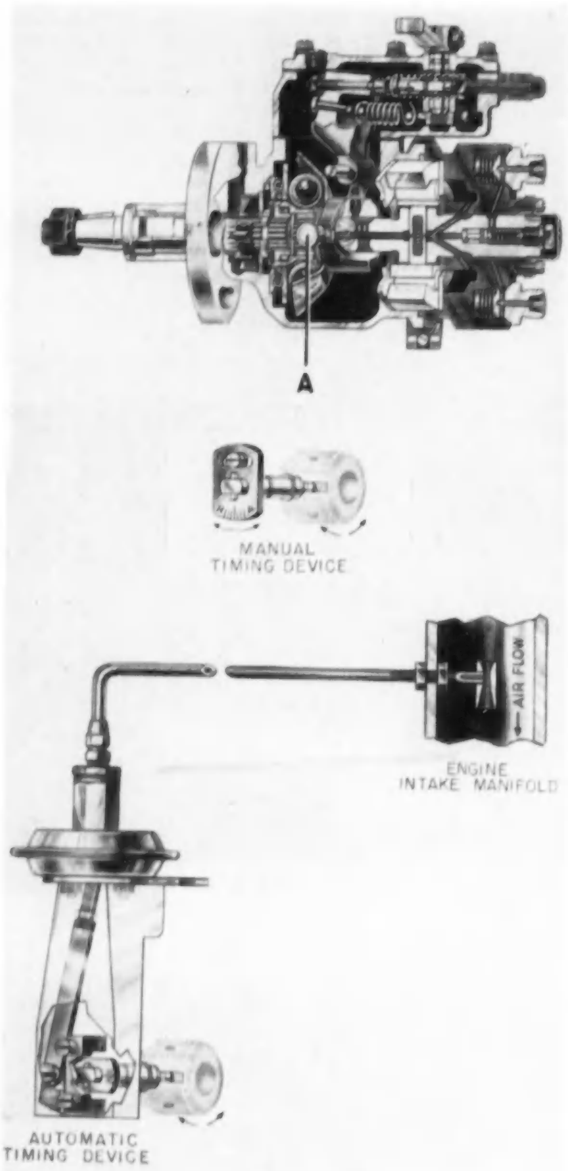


Fig. 9—Injection timing and fuel supply.

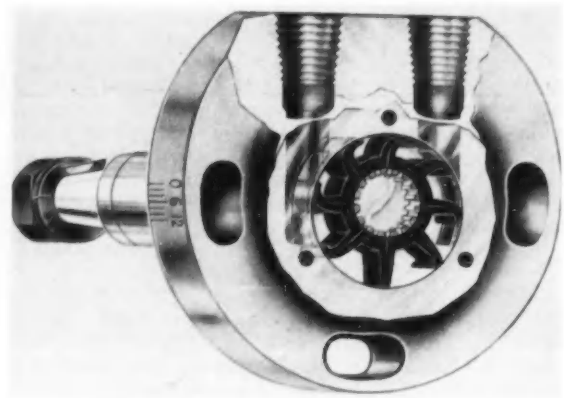


Fig. 10—Fuel supply pump.

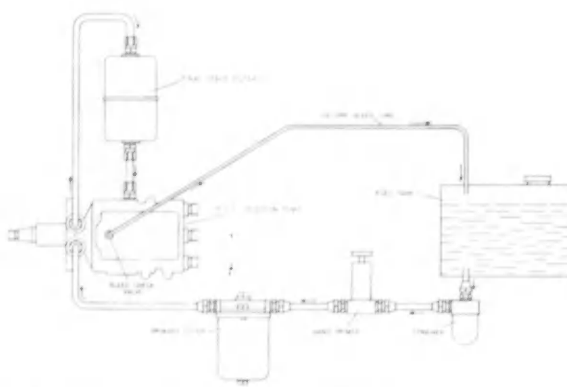


Fig. 11—Fuel system for PDA injection pump.

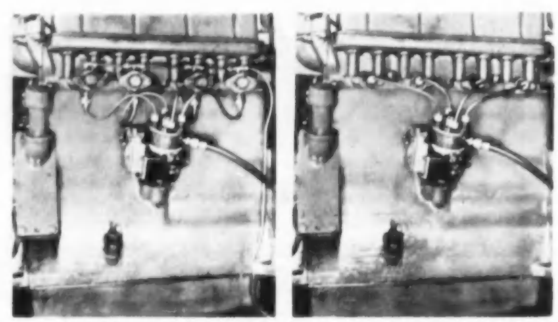


Fig. 12—Shank-mounted PDA pump.

against the thrust-bearing (D) and the cone (E), forcing the cone and the metering sleeve (cone and sleeve are one piece) to the right as the speed increases. The fulcrum lever (F) cooperates with the sleeve by means of a pin (G) confined by a slot (H) in the sleeve. The outward end of the fulcrum lever carries the governor tension spring (K) which connects with the manual operating shaft (J).

The governor is shown in the idling position. Note that the tension spring is pushing against the idle screw (L). The high-speed-stop screw adjustment (M) is located to the right of the idle screw. The full-load fuel-adjustment screw (N) carries the resilient stop (P) used for torque control. The screw also carries the spring capsule (R). This provides automatically 100% excess fuel for starting when the manual operating shaft is in full-speed position.

Either Manual, Fixed, or Automatic Timing

We have seen how an axial movement of the sleeve meters the fuel. Also, we have noted how turning the sleeve changes the injection timing without disturbing the metering operation.

In order to have fixed timing, a pin (A) is installed (Fig. 9) which prevents the sleeve from turning. If an adjustable pin is used (also Fig. 9),

the timing may be manually adjusted through a total range of 5 cam deg.

Automatic timing is also illustrated in Fig. 9. Air in the engine intake manifold is allowed to flow through a small venturi. The venturi is connected to a diaphragm which is linked to the injection timing lever and the movable pin. A small pressure drop will turn the sleeve since the turning force required is only the frictional force of the sleeve on the rotating shaft.

At high speeds, engine performance is improved if the injection timing is advanced automatically as a function of speed.

Fuel Supply Pump and System

The fuel supply pump (B, Fig. 9) is mounted on the drive shaft in the forward end of the injection pump housing. The supply pump consists of a simple flexible-vane impeller surrounded by an eccentric bore, and is reversible and self-regulating. An enlarged view of the supply pump is shown in Fig. 10.

Fig. 11 shows a typical fuel system for the PDA injection pump. Note that the pump is continually vented to the top of the fuel tank through a small non-return valve. This type of system is popular because it prolongs filter life: The only fuel passing through the filters is the fuel delivered to the nozzles plus the small bleed flow.

Either Flange, Base, Or Shank Mounting

The PDA pump may be flange mounted in the manner of the multi-element APE pump, or it may be shank mounted in the manner of an ignition distributor. The shank mount can be equipped with adapter flanges. Then the pump may be switched among flange, base, or barrel mountings already in use.

Fig. 12 shows the shank-mounted pump. The view at the left shows the conventional nozzle-holder arrangement with its leak-off connections. The view at the right shows a new-type screw-in holder making use of an outwardly opening nozzle which requires no leak-off. Use of the screw-in holder greatly reduces the cost of the injection system.

American Bosch recommends their PDA pump for applications requiring up to 130 cu mm of fuel per stroke. Speed limitations of the pump are well above the needs of existing engines.

Radioisotopes . . .

. . . are a "natural" for the measurement of wearing parts. Problems can often be solved with minimum facilities and personnel. Varied applications indicate bright future.

Based on paper by **A. M. Smith,** Ford Motor Co.

RADIOISOTOPES can be used to tag a system which requires study. Mechanical parts can be tagged and then located by radiation measurements when visual observation is impossible. Other systems can be tagged to permit the tracing of minute quantities of material, or the tracking of a particular chemical element through complex chemical processes. Typical uses in the automotive field are the measurement of piston ring rotation, air flow, head gasket coolant leaks, and oil mixing.

Some work has been done with filter efficiency measurements. Although increased precision of measurement appeared possible, the processes tried for isotope measurement could not compete in simplicity.

Among other applications may be mentioned:

- Successful measurement of blast furnace retention of directly-fed, powdered iron ore concentrates. In this instance, about 3 lb of the test material was followed as it became mixed with hundreds of tons of foreign material.

- Measurement of the metal thickness between a drilled hole and the outside of a casting.

- Study of the operation of a sinter plant for clinking iron oxide powders by means of tracers.

- Direct measurement of oil consumption of automotive engines during tests. This application is under investigation.

Application of isotopes is less than 10 years old. In the next decade the useful range will be much better defined. Future developments will probably include the following:

1. Radioactive sources will replace x-ray units where economy and portability are important.

2. New applications will be developed for radiation effects on structural materials and gases.

3. Radioactive measurements of trace quantities of material in mixtures will progress as the knowledge of radioactive techniques spreads.

4. Techniques should come into general use for following tagged materials radioactively through industrial processes or locating the position of hidden machinery parts.

(Paper "Radioactivity and Automotive Measurements" was presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 14, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Memo to Manufacturing Men:

How to Make Production

IF you're a manufacturing man, crash programs are the goblins of your nightmares. More than ever before you'll be looking to production planning to level out the peaks and valleys, spurts and slowdowns of the manufacturing program cycle in your plant.

You know that effective production planning and schedule development grow out of a well-marshalled grouping of many facts. And you know too that you have to rely on the talents of your sales people, accounting, and top management to get the results you want.

Chances are you'll start your production-schedule making with a sales forecast for an extended period. It will show what products are going to be sold, how much, and anticipated delivery schedules. To round out the forecast package, you'll also want sales figures for the past fiscal period—both actual and estimated.

The sales forecast is your springboard for working up your shop schedules . . . dates raw materials must be in the plant, tooling needs, and required delivery dates.

You'll look to the accounting representatives on the production planning team to keep you in line. They'll see to it that you don't strain your company's financial resources by over-producing or over-purchasing.

You're going to want to know pretty quickly about the availability of raw materials so you can provide enough lead time for getting them into the plant. You're going to work closely with engineering to be sure that all product changes have been considered and that there's a firm fix on the design. You'll want to make sure that all tooling changes are made in your shop as well as the subcontractor plant. And you will want to give your suppliers enough lead time to produce component parts.

Management will probably expect you to produce more this year than last on the same tools. So it's wise to reflect that in your fabrication schedules. In case you've had recent layoff in the plant, you'll want to think about availability of additional labor . . . and the time to train new employees.

Even though you seldom achieve the utopia of a constant level of production, you can iron out some of the uncertainties. That's by building nonchanging component parts *ahead* of concrete purchase orders. When sales comes in with a definite order, you can reduce your lead time.

You'll make your planning job simpler if you can get the sales forecast to reflect units (and types) to be sold, instead of merely dollar volume. Dollars tell you little about quantities, particularly in a multi-product operation.

If you're wise, you won't let paper work rob you of precious lead time. You'll trim your operations of cumbersome records which were probably in vogue in your plant during the time of tremendous backlogs.

Chances are that you keep an ever-watchful eye on inventories. You'll work out inventory levels of service parts with the engineering department's help. The design engineers will tell you what parts will wear out and the ratio of these parts to the population of the product in the field. You proba-

Behind the Facts . . .

. . . in this article is the collective experience of the 8-man panel, out of whose session grew the report. These men, who threw light on "Taking the Guesswork Out of Production Planning" at Milwaukee in September 1954 are:

Leader: L. W. Perkins,
International Harvester Co.

Secretary: R. J. Hohenfeldt,
Ladish Co.

Panel Members:

Ben Bugbee,
Falk Corp.

John Martin,
Arthur Andersen and Co.

Luther Schmidt,
Allis-Chalmers Mfg. Co.

R. F. Luckes,
Chain Belt Co.

Del Hansen,
J. I. Case Co.

H. C. Taylor,
The Heil Co.

Planning Work for You

R. J. Hohenfeldt, Ladish Co.

Based on secretary's report on Taking the Guess Work Out of Production Planning, held as part of the SAE Tractor Production Forum, Milwaukee, Sept. 13, 1954.

bly build up your service parts inventories during slow periods of direct product sales to keep from upsetting regular production schedules.

You look to establishing realistic inventory levels as a way of smoothing out employment peaks and valleys. You know it costs the company money and time every time you discharge an employee and later rehire a replacement.

You know that setting inventory levels is a tricky job. Peg them too high and you tie up the company's capital. Set them too low and you jeopardize the company's position with its customers; or you may have to break into a regular production run to produce service parts.

Dollars aren't your only consideration in setting inventory. You take a hard look at storage facilities, obsolescence, deterioration, and dollar turnover in a given period. If your situation is an average one, 20% of the inventory in stock represents 75% of the inventory dollar volume. It's this 20% that you watch closely to avoid dollar losses.

You probably use the "A-B-C" method of categorizing inventory to give you a quick picture of dollar value versus quantity of inventory on hand. ("A" covers the most expensive items; "B" the lesser items; and "C" the least expensive.) Included in the valuation are the cost to store, deterioration, and obsolescence.

Experience has probably taught you that one sure way to invite disruption of production lines is to give your suppliers too little lead time. You probably have worked out a rule of thumb for figuring length of commitments, which goes something like this:

1. One month finished production inventory on hand available for shipment to the prime manufacturer on request.
2. One month inventory of material in process.
3. One month supply of raw material on hand.

In setting up and altering production schedules, you recognize your obligation to suppliers and subcontractors as well as to your own plant.

You know it's good business to familiarize your shop foreman with the long range production schedule and expected sales. In case of breakdown in the plant, he can substitute jobs without materially affecting sales commitments.

When you bring a rush job into the shop, you also tell your shop supervision which jobs should be pushed back to make way for the priority job. You may have found it helpful to assign priority numbers to all jobs in the shop.

If you head up a large enough manufacturing operation, you have found it wise to assign a production scheduler in each shop department or series of related departments. He establishes production schedules on a departmental level and relieves the foreman of paperwork. The schedule is under direct supervision of your production control supervisor. It's best for overall integration.

Your scheduler, if you have one, generally gives the foreman three or four jobs which must be handled. He'll allow the foreman to juggle the schedule to take fullest advantage of his machines and manpower. You'll want to give your foreman as much flexibility as possible, to apply control only where it's needed. But you'll rely on the production scheduler to see that the schedule is maintained and met.

You, like most other manufacturing managers, are casting an eye at new computers to work out your knotty scheduling problems. You're attracted by the possibility of getting answers faster, and with fewer people. But you know also that you have to weigh the economics before you buy a machine. Current price and availability of clerical help may show the machine to be too expensive for your operation. You know that digital computers and punch card systems are not a panacea. You'll investigate them carefully before you install them.

(The report on which this article is based is available in full in multilith form, together with reports of the other panel sessions of the 1954 SAE Tractor Production Forum. This publication, SP-308, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

Robert D. Roche,

Staff Meteorologist, Georgia Division,
Lockheed Aircraft Corp.

Based on paper "The Jet Stream: Sky-High Overdrive," presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 18, 1955. This paper is available in full from SAE Special Publications Dept. Price: 35¢ to members, 60¢ to nonmembers.

SURFACE WINDS average out about like this. Meteorologists at first suspected World War II high-altitude airmen's reports of very-high-speed winds aloft because surface data gave no hint of their existence.

The Jet Stream:

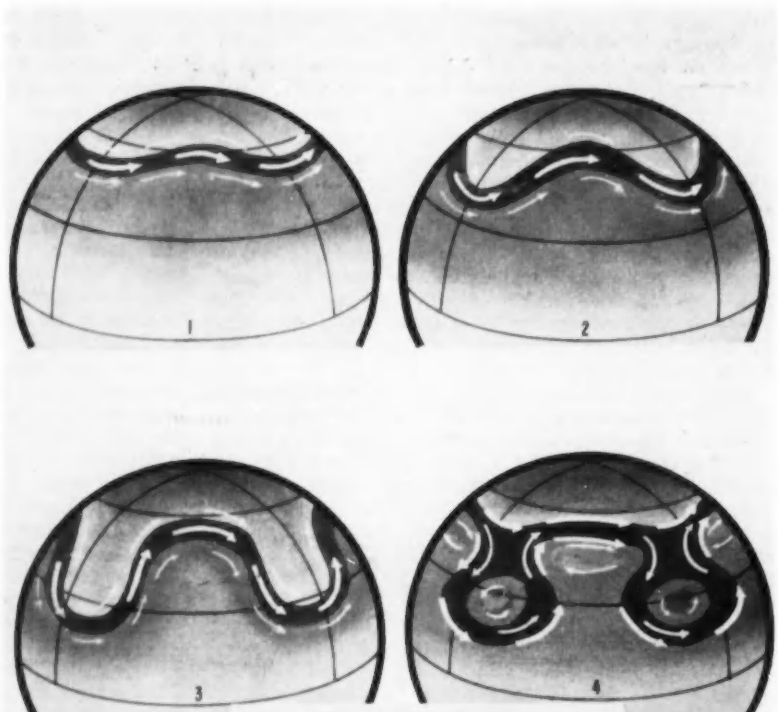
OSCILLATIONS OF THE JET STREAM follow a growth-and-decay pattern like those of other types of fluid wave motions. Jet stream core, which is seldom wider than 100 miles, goes through these four phases. Each phase takes a week or a little longer, so that the complete cycle takes something like four to six weeks.

Superimposed on these long-period convolutions are numerous daily fluctuations of shorter wavelength and smaller amplitude.

The total motion is a mechanism for exchanging air between polar and tropical latitudes, sufficient for maintaining the latitudinal temperature distribution we observe in nature.

Vertical location of the jet stream coincides with the tropopause, that boundary between the troposphere and the stratosphere. Normally, the tropopause slopes upward in the atmosphere from near 25,000 ft over the poles to 60,000 ft over the equator.

Altitude of the jet stream correspondingly varies with the latitude. A jet stream over the Dakotas might be found at 30,000 ft. But over the Gulf of Mexico it would be closer to 50,000 ft. Also, the jet stream is normally centered above and behind a pronounced cold front.



TYPICAL SEQUENCE OF JET STREAM CHANGE
(AFTER NAMIAS)

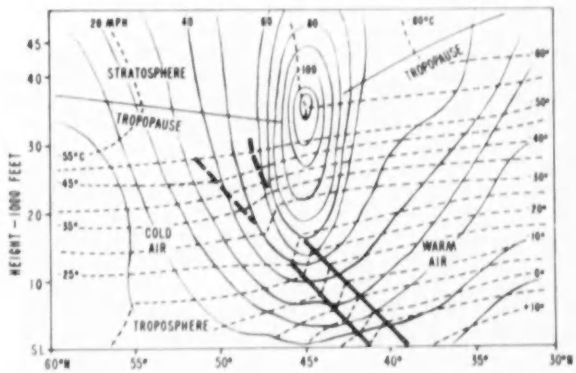
HIGH-ALTITUDE WINDS, we now know, form a vast circumpolar whirl. Embedded in it is a zone of mean maximum velocity near latitude 30 deg North. University of Chicago meteorologists christened it a jet stream in 1946.

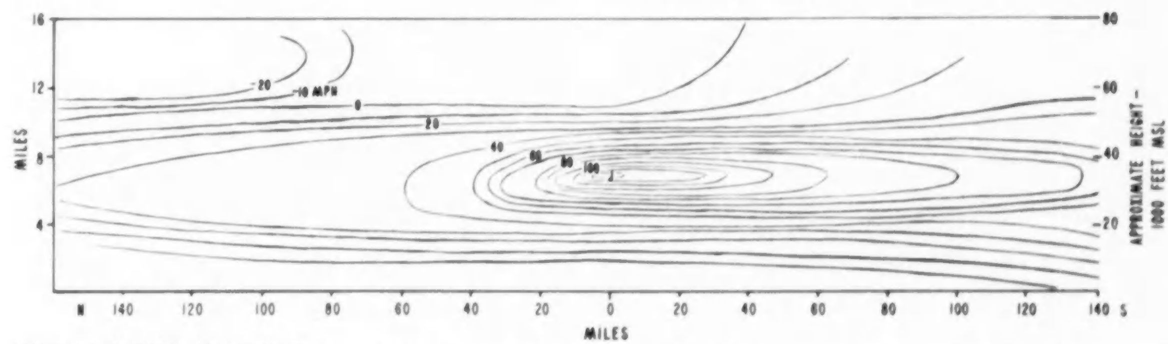
JET STREAM MEANDERS north and south about a mean position. In winter, this mean is near 25 deg latitude, and average speed is about 100 knots. In summer, the mean is nearer 45 deg, and speed is more like 50 knots.

Sky-High Overdrive

VERTICAL CROSS-SECTION through a typical jet stream shows that the stream is a narrow core of high-velocity air surrounded on all sides by flows of radially diminishing speed. (Here abscissa scale is compressed 150 times ordinate scale.)

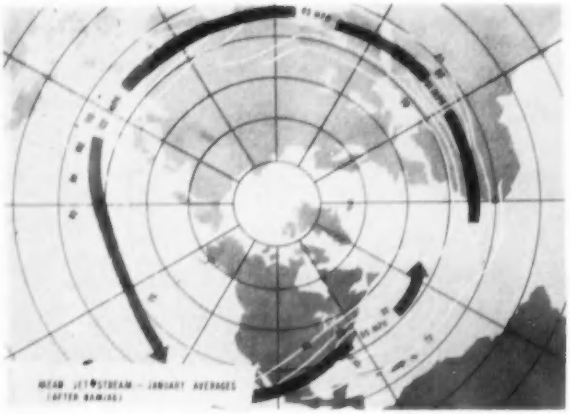
The heavy lines in the foreground denote low-level polar cold fronts. When a major polar frontal system invades the lower atmosphere, there is established a strong thermal contrast throughout a deep layer of the troposphere. We don't know just why jet streams top these discontinuities, but we know they usually do.



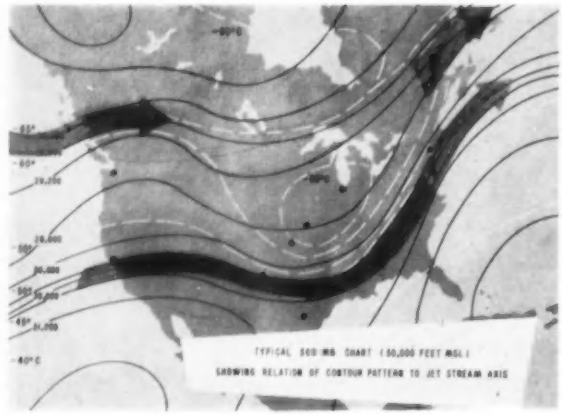


STREAM ITSELF IS THIN, narrow ribbon, elliptical in cross-section. (Here abscissa scale is compressed five times ordinate scale.)

Core speeds of 200-300 knots have been observed and verified frequently. There's no reason to doubt occasional reports of wind speeds very close to 400 knots. Horizontal velocity gradient frequently exceeds 1 knot per nautical mile. Vertical gradient may be 100 knots per 5000 ft.



INTENSITY VARIES as the jet stream circles the northern hemisphere. This plot shows average speeds. The variation is more marked in an individual jet stream. Not only do these maxima vary with time, but they also translate along the axis of the stream at speeds of 50 to 60 knots. Maximum speeds occur off the east coasts of major continents.

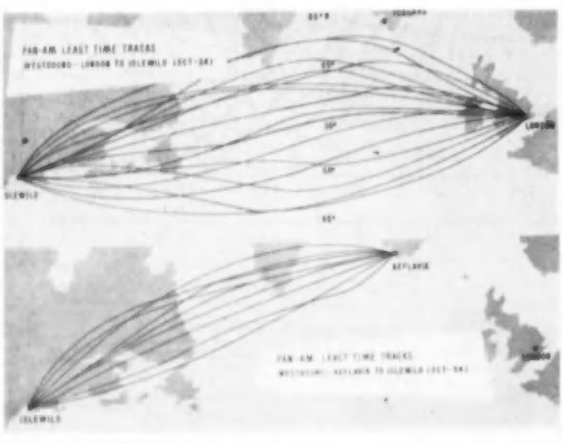


WEATHER MAP of this general type shows aeronautical meteorologist where jet streams are likely to be. This is a horizontal cross-section at the 300 millibar pressure surface. It can be thought of as a pressure pattern at about 30,000 ft. The solid lines, then are like isobars. The more crowded the lines, the faster the flow—a clue to jet stream location.

What the Jet Stream Means to the Airlines

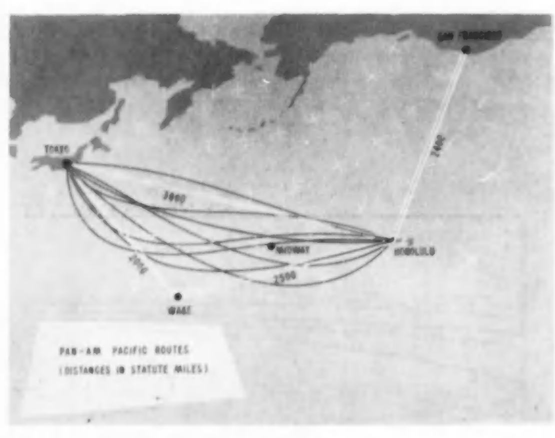
THE jet stream can serve as wind aid to increase range or decrease flight time. There are combined techniques involving meteorology and navigation which permit computation of minimal flight paths. This involves a moving and changing wind system over a spherical earth. This is not new—you may be familiar with it under the name of "pressure pattern flying." It is now often called "least time track" navigating, and simply establishes the track that has maximum wind aid over a route.

This type of operation is not to be confused with simple tail winds on an east-bound flight at high altitudes. "Jet stream operations" entail high-powered meterological advice during the pre-flight stage,



LEAST-TIME TRACKS computed by Pan American World Airways meteorologists for October 1954 deviate as much as 500 miles north or south of a great-circle course. (On this projection, the great-circle course lies about in the middle of the network of route lines.)

As the lower diagram shows, on the Iceland-to-New York hop, the short way to Long Island is often via Montreal and Albany.



SAVINGS ARE STRIKING on Pan-Am's trans-Pacific flights. Utilization of the jet stream permits direct Tokyo-Honolulu operation, saving 5-6 hr. At $500 per hr, that's $2500-3000 per trip. From November 1954 to April 1955, jet stream utilization saved 230,000 gal of fuel on Tokyo-Honolulu flights. Besides, for every two jet stream flights to Honolulu, enough engine hours are saved to fly from San Francisco to Honolulu.

and capabilities of air crews to locate accurately the jet core during the airborne period. Obviously, the usefulness of the jet stream is limited . . . at times it will not be within the desired area . . . or be too weak to justify a deviation from great-circle track . . . or possibly be too high, above the aircraft power-limited ceilings.

For aircraft with reciprocating engines, air speeds of 200–300 mph, and altitude limits near 30,000 ft, the jet stream is of real significance, for its speed is frequently 50–100% of the aircraft's speed. For example, over Japan and the western Pacific, in winter months, winds are greater than 100 knots about 60% of the time at 30,000 ft.

With turbine-engine aircraft, the effect of the jet stream wind aid is not as large, since the speed is only 25–50% of the aircraft speed. But it is every bit as significant to the flight. For, as a matter of fact, the jet aircraft not only has the capability of reaching the altitude of the jet stream core . . . it further is required to cruise at the same altitude at which the jet stream center is most often found, 30,000–40,000 feet. Accurate knowledge of these jet stream winds is vital then, even if the flight is not seeking wind aid.

Even more than commercial aircraft, military aircraft are concerned with jet streams. A bomber pilot on a strategic mission may be more interested in range extension rather than least-time flight. But his problems of navigation, fuel consumption, and rendevous times are very much more critical than any commercial operational problem. Even, for example, on his bombing run, unknown wind speed or a zone of marked temperature gradient, or a patch of clear-air turbulence can ruin the mission. All of these are common attributes of the high tropospheric jet stream.

That's why both the USAF Air Weather Service and the Navy AROWA Project have taken the lead in jet stream research.

What the Jet Stream Means to the Airframe Designer

AIRCRAFT operating at high altitudes are going to encounter the jet stream—whether they seek it or not—and experience the clear-air turbulence associated with its periphery. Maximum acceleration forces are seldom more than 0.5 *g*. But the resulting forces are significant because the pilot can't see the clear-air turbulence and therefore penetrates it at high-speed cruise.

One set of data indicates that approximately 68% of the occurrences of clear-air turbulence at high altitudes were in the vicinity of jet streams. So jet stream effects are significant phenomena, even though they are not so frequently encountered nor so severe as lower-altitude turbulence.

Designers of high-altitude, high-speed aircraft will need to take into consideration the fatigue effects of repeated encounters with this new category of rough air.

Discussion

—Philip Donely,
National Advisory Committee for Aeronautics

UTILIZATION of the jet stream during routine transport operations will not significantly affect the fatigue life of an airplane structure. This is indicated by consideration of the structural problems of ultimate load failure and fatigue together with current information on atmospheric turbulence and operating practices.

Jet stream experience is very limited, but for the class of airplane that stands to gain by riding the jet stream, gusts from all sources contribute about half of the fatigue damage, the remainder being ascribed to maneuvers, landings, and take-offs. Some insight into the contribution to fatigue damage of the jet stream can be gained by assuming a doubling of the number of gusts above 20,000 ft. The total number of significant gust loads is increased about 50% and the fatigue life is decreased to about $^3/_4$ of that for current operating practices. Flight in the jet stream is not always rough, and since it is intentionally flown only when it aids the progress of flight, the increased time in turbulence above 20,000 ft might increase about 10 to 20% on the average. On this basis, the fatigue life might be reduced 5 or 10%, which is not considered significant.

Rubber's Tendency to Crack

THE tendency of a given rubber to crack varies from locale to locale, from time to time, and even from northern exposure to southern exposure at the same spot.

Rubber samples from the same lot cracked more in Chicago, Ill. and Birmingham, Mich. than they did in Clearwater, Fla. and San Diego, Cal. Summers were more severe on rubber than winters in some areas—less severe in another area.

It's possible that these variations are explainable by fluctuations in the ozone content of the atmosphere. But ozone concentration doesn't seem to account for another effect observed in samples exposed at Shapleigh, Me. and Chicago: They frequently cracked more on the north side than on the south side.

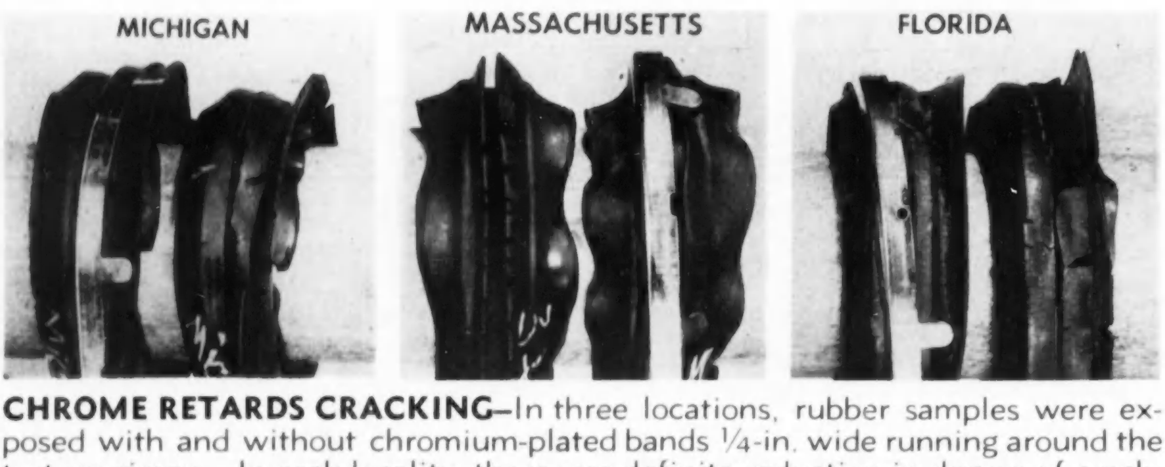
In all these cases, the samples were 10-in. lengths looped and fastened lanyard-style around a 2-in. OD wooden mandrel with midpoints 45 deg up from the horizontal as prescribed in ASTM D 1171 (The American Society for Testing Materials' Tentative Method of Test for Weather Resistance Exposure). Only the center 5 in. of the strip is rated for cracking; the clamped ends don't count. ASTM D 1171 sets forth a visual, 0–3 rating scale with 0 for no cracking and 3 for severe cracking.

To study geographical variations in degree of cracking, a batch of a typical rubber was mixed and extruded in weatherstrip form. All strips were cured in a heater at the same time, then cut into 10-in. lengths, packed in cardboard cartons, and shipped to five exposure sites: Chicago, Clearwater, East Weymouth, Mass., San Diego, and Birmingham, Mich. (These locations were known to encourage cracking.)

Since all samples were mixed and cured simultaneously, the only variables were (1) geographical locations, which might entail variations in ozone concentration, and (2) aging of the strips.

First strips were set out in April 1952 for 30 days of exposure. Every 7 to 10 days thereafter over the next 17 months, samples were examined for cracking and additional samples were set out. Each sample, after its 30 days of exposure, was rated on the 0–3 scale.

At the end of the 17 months, over 50 specimens



CHROME RETARDS CRACKING—In three locations, rubber samples were exposed with and without chromium-plated bands ¼-in. wide running around the test specimen. In each locality, there was definite reduction in degree of cracking when the chromium-plated band was used. These results confirmed observations that chromium-plated trim around a windshield or backlight gasket retards cracking.

Herbert A. Winkelmann,
Technical director, Dryden Rubber Division, Sheller Mfg. Corp.

Based on paper "Weatherseals in Automotive Applications" presented at SAE Golden Anniversary Passenger Car, Body, and Materials Meeting, Detroit, March 1, 1955.

Is Unpredictable

Table 1—Average Ratings of Exposed Rubber Samples

Exposure Period	No. of Samples	Chicago, Ill.	Clearwater, Fla.	East Weymouth, Mass.	San Diego, Calif.	Birmingham, Mich.
		ASTM D-1171—Average Rating After 30 Days				
April through Aug. 1952	15	1.93	0.73	1.78	1.53	1.13
Sept. 1952 through March 1953	26	1.00	0.53	0.92	0.76	2.26
April through Aug. 1953	16	2.43	1.62	1.85	1.13	2.20

had been exposed in each location. Here's how the ratings averaged for the five locations:

Location	*Average Rating*
Chicago	1.64
Clearwater	0.89
East Weymouth	1.38
San Diego	1.07
Birmingham (Mich.)	1.94

Chicago and Birmingham (Mich.) showed much more cracking than did Clearwater and San Diego. More surprising, variations of the same magnitude appeared from year to year and season to season at given locations. Table 1 shows this seasonal variation for all five sites. Cracking was more severe in the summer of 1953 in Chicago, Clearwater, and Birmingham than it was in the summer of 1952. Yet in San Diego, samples cracked more in the summer of 1952 than in the summer of 1953.

There was more cracking during the summer of 1952 and 1953 than during the intervening winter, except at Birmingham.

Presumably the cracking is due to ozone—which we know does crack rubber and does vary in concentration from place to place and time to time. We know, for example, that ozone concentration is high in certain California areas. (Where the ozone comes from is debatable. Some investigators attribute it to the effect of sunlight on the large amounts of hydrocarbons and nitrogen oxides from combustion processes. Others claim that these man-made sources couldn't account for more than mere traces of ozone in the atmosphere. They feel that the ozone originates in the stratosphere over the Pacific.)

Ozone probably isn't the only culprit either. Investigators have shown that stressed rubber cracks on exposure to certain free radicals resulting from the photolysis of volatile peroxides, in the presence of nitrogen. These radicals include tertiary butoxy, phenyl, benzoyl, acetyl, and hydroxyl radicals. Nitrogen peroxide functions as a catalyst.

Whatever effects these other substances have on cracking, ozone-chamber test results do, however, follow the general pattern of Chicago test results. In two ozone chambers containing 25 parts of ozone per 100,000,000 parts of air, specimens were exposed on wooden mandrels for 70 hr at 100 F. Results on 2100 samples exposed in the two chambers show the same trend as 1050 samples each exposed for a 30-day period sometime between November 1952 and May 1954 outdoors in Chicago. Table 2 gives the comparison on the three lots of 1050 samples each.

The ozone chambers gave similar results although

Table 2—Results of Chicago Exposure Versus Ozone Chamber Exposure

Rating	Ozone Chamber 1[a]	Ozone Chamber 2[a]	Chicago, Ill.[b]
	Number of Samples at Each Rating		
0	413	449	439
1	99	70	115
2	227	161	147
3	311	370	349
Total	1050	1050	1050

[a] Ozone Chamber: 70 hr at 100 F, 25 parts ozone per 100,000,000 parts of air.

[b] Chicago: 30-day periods from November 1952 through May 1954.

they were in different laboratories. This gives hopes that, if equivalency with outdoor aging can be established, an accelerated laboratory test for rubber cracking can be worked out.

It's easy to see how variations in chemical make-up of the atmosphere cause geographic and seasonal variations in rubber's tendency to crack. But we have no such explanation why north sides of samples tend to crack more than south sides.

This north-south variation in cracking tendency showed up in results of tests run in Maine. A total of 792 test pieces—some standard test strips and some commercial weatherstrip—were exposed near the shore of Mousam Pond at Shapleigh, Maine. Exposure began May 31, 1953 and lasted 60 days. The mandrels on which the samples were mounted were 30 in. above the ground, with the axis running east-west. Ends of samples pointed downward, instead of at the 45 deg angle ASTM D 1171 mentions.

Of the 792 samples, 41.4% showed more cracking on the north side than on the south. Only 17.6% showed more cracking on the south side. (Of the remainder, 18.4% showed equal degree of cracking on the two sides and 22.6% showed no cracking.)

The same trend was noted in subsequent Chicago exposures. Of the samples showing more cracking on one side than on the other, two-thirds showed more on the northern side.

Examination of cars on a storage lot confirmed results of north-south exposures on mandrels. The cars stood in rows, the cars in one row facing north and those in the next facing south. No matter which end of the car faced north, the tendency was to show more rubber cracking on that end.

Another interesting though puzzling trend noted by Ford Motor Co. engineers is that chromium-plated trim around a windshield or backlight gasket retards cracking of the rubber strip.

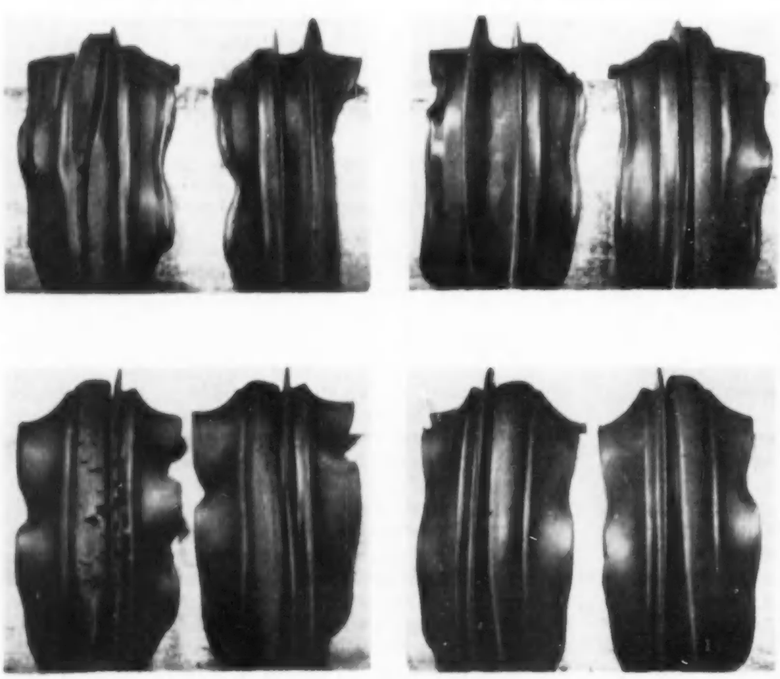
(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

MORE CRACKS ON THE NORTH SIDE—Tendency to crack on the northern exposure was about two and one-half times as great as on the southern exposure among 792 samples exposed at Shapleigh, Me., on the shores of Mousam Pond. Of those that cracked more on one side than on the other, 41.4% cracked more on the north side; 17.6% cracked more on the south side. (Of the others, 18.4% showed equal degrees of cracking on both north and south sides, and 22.6% didn't crack.)

Examples shown are commercial weatherstrip. They were exposed 30 in. above the ground around wooden mandrels mounted with their axis running east-west. That way, one side of sample faced north, the other faced south.

Only noticeable difference in environment between north and south exposures was pine and birch woods about 15 ft north of the samples.

NORTH **SOUTH**



"To Unite People

—On that depends the destiny of our age."

BRIAN G. ROBBINS (right) and Dr. E. A. Watson (left), were guests of President C. G. A. Rosen last June at SAE's Golden Anniversary Summer Meeting. This article is excerpted from the message Robbins brought from England to the SAE on that occasion. . . . An officer in the British Army in World War II, Robbins handled the technical training of army personnel.

by Brian G. Robbins,
Secretary, Institution of Mechanical Engineers

THE automotive engineer has benefited humanity by giving people power of movement for commerce and recreation. The industry has made a vital contribution to civilization by meeting the needs of the millions right across the world.

It is most significant, however, that for approximately one-quarter of the life of the SAE, either the United States or Great Britain or both have been engaged in war—an activity that has demanded swift development of all forms of land and air transport.

We acknowledge the progress made in our mechanical art, but we regret the urge that war has given to it.

Such thoughts passed through my mind this Eastertide. I was standing with a farmer friend of mine on one of his hills overlooking Poole harbour in Dorset. He said to me:

"Eisenhower, Churchill and Montgomery stood just where you are standing, a few days before D-Day. They were watching the final practices down there in the bay, for the Normandy landings."

It made me realize that it was the urgency of such an undertaking—11 years ago now—that was responsible for tanks that flame-throw, vehicles that wade and swim and aircraft that carry atomic weapons.

I believe that birthdays should be marked by more than mere celebration—surely by assessment of the past and dedication for the future.

It is helpful to have the goodwill of our friends—the world would be a lonely place without it—but goodwill of itself between the SAE and the Institute of Mechanical Engineers is not enough. If that is all we have, that is all we have the right to expect between our respective nations. That relationship of itself will not be adequate to build peace in our age.

Professor Moon of Chicago, an atomic physicist, said last year in London: "We now have the absolute weapon. We now need people living absolute moral standards to control it." That is true.

We engineers and scientists have produced the internal-combustion engine and split the atom, but we have yet to learn to unite people. On that depends the destiny of our age.

We have been trained to work in three dimensions. We feel safe there. We know our limits. We work to high standards of accuracy and we apply recognized tolerances. But as Professor Moon says, the world needs people today who apply such standards not only to machines but to themselves. It needs people who add a fourth dimension to their living—the dimension of the spirit.

Automotive engineers on both sides of the Atlantic have a united contribution to make in this way. We have wars—both industrial and international—because we cannot make peace. Peace will only be assured by people being different. If we as individuals think straight we shall act straight. With this fourth dimension we can help to bring renaissance to the world.

Two Designs of Tubeless

Goodyear's . . .

C. R. Case
The Goodyear Tire and Rubber Co.

Based on paper "A Universal Program for Tubeless Truck Tires" presented at SAE Golden Anniversary Summer Meeting, Atlantic City, N. J., June 16, 1955.

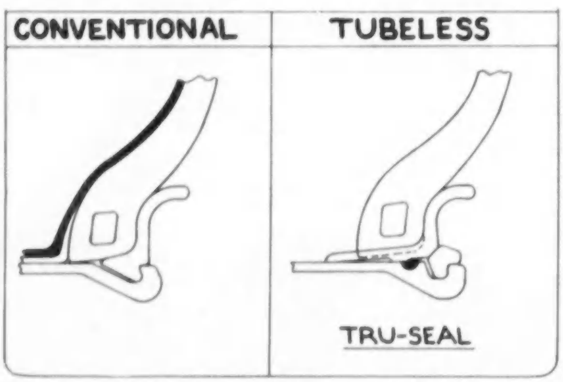


Fig. 1—Conventional truck tire and tube compared with Tru-Seal tubeless tire.

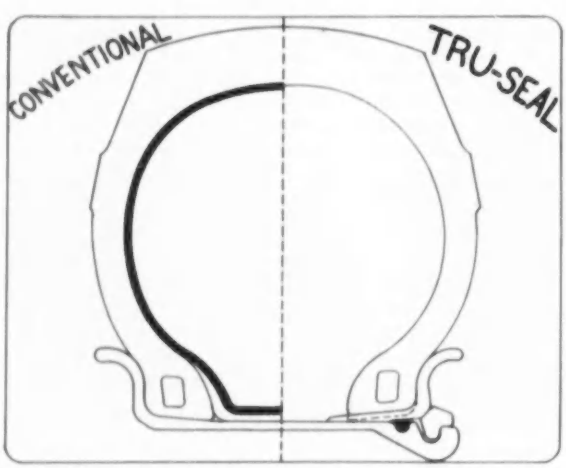


Fig. 2—Comparison of diameters of conventional rim (light truck) and Tru-Seal rim.

WHILE developing the Tru-Seal gasket, we at Goodyear became convinced that the most successful truck tubeless tire program must:

1. Be practical and economical for all tire sizes.
2. Retain the design and performance characteristics of the conventional tire.
3. Minimize difficulties in changing over from the conventional tire to the tubeless.
4. Simplify tubeless maintenance.
5. Exploit the tubeless safety characteristics.

Rather than experiment with a new rim design which in the long run may prove inadequate, we have installed our tubeless on the tried and proven three-piece rim.

In Fig. 1 note the similarity between the conventional tire, tube, and rim assembly and the Tru-Seal design. Our tubeless requires a change of only ¼ in. in the diameter of the conventional truck rim (Fig. 2). With this change, the inside dimensions of the rim are maintained, the base of the 5-deg tapered bead is fully supported by the rim flange, and space is provided for the gasket. Only the bead diameter is slightly altered.

Universal Application

The number of different conventional truck tire sizes now available is well over 100. Tire cross-sections run from 6.00 on small trucks up through 37.50 on the largest earthmovers. Rim diameters range from 15 to 33 in. Ply ratings run from six to 60. The Tru-Seal program provides a tubeless replacement for each corresponding conventional tire.

Future trends in truck design point toward lower platform height and greater cubic capacity. These trends have been indicated by the development of the high-load tire for small diameter rims. The Tru-Seal design is completely adaptable to small

CONTINUED ON PAGE 52

Truck Tires:

Firestone's . . .

T. A. Robertson and R. P. Powers

The Firestone Tire & Rubber Co.

Based on paper "The New Drop Center Tubeless Truck Tire" presented at SAE Golden Anniversary Summer Meeting, Atlantic City, N. J., June 16, 1955.

BECAUSE of their stiffness and large size, conventional truck tires of more than eight plies have been mounted on multi-piece rims with removable flanges (Fig. 1, left). In order to mount a tubeless tire, these rims must be made airtight—either by using gaskets to seal the rim parts or by designing a new one-piece rim.

The new one-piece drop-center rim (Fig. 1, right) was selected for its:

1. Simplicity in rim design and ease of tire changing and rim maintenance.
2. Weight savings, particularly in rim metal.
3. Applicability to most tire sizes.
4. More comfortable ride.
5. Greater safety.

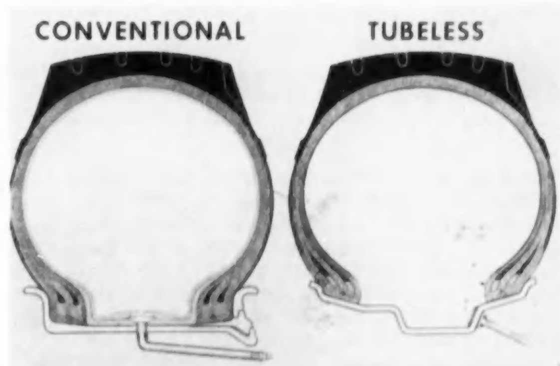


Fig. 1—Conventional truck tire and tube compared with drop center tubeless tire.

Simplified Rim Means Simplified Maintenance

Fig. 1 (left) shows the conventional truck tire, tube, and flap assembly mounted on a standard three-piece rim—an assembly of six component parts. This tire is supported almost entirely by the high rim flanges. These flanges also serve to hold the beads against the side forces caused by pressure inside the tire.

In Fig. 1 (right), the airtight inner liner (an integral part of the tubeless tire) replaces the conventional tube and flap. A single unit replaces the three-piece rim. Note that the entire base of the bead holds the tire to the rim. Although molded much smaller than the rim, the tire is forced very tightly by air pressure into the 15-deg tapered rim seat. This forced taper fit is the secret of the airtight seal. The fit carries most of the side load, thus eliminating the need for a high flange. The small drop-center flange merely centers the tire on the rim.

Fig. 2 shows the parts and tools needed to mount a truck tire, tube, and flap on a conventional three-piece rim.

Fig. 2—Parts and tools needed for mounting conventional truck tire.

Mounting the drop-center tubeless tire is illus-

Fig. 3—First step in mounting the drop-center tubeless tire is to place the tire on the rim so that one bead is in the well.

Fig. 4—Second step in mounting the drop-center tubeless tire is to button the second bead over the rim.

trated in Fig. 3. First, the tire is placed on the rim so that one bead is in the well. For tire sizes up to 9.00-20 this can usually be done without using tools. Next, the other bead is pushed over the flange and buttoned (Fig. 4). The low flange of the drop-center rim is an advantage in mounting the tire. The flange also eases the job of breaking the airtight seal when the tire is removed from the rim.

In our opinion, the simplification of rim parts is one of the most attractive advantages of the drop-center tubeless. Fewer parts are required for handling and inventory. Now, truck tires may be mounted on an assembly line basis. Even without an assembly line, the drop-center tubeless can be mounted in less than half the time required to mount a conventional tire, tube, and flap.

With a multi-piece rim, there is always the danger of some of the pieces becoming bent and flying apart when the tire is inflated. In some multi-piece rim designs, the side rings or lock rings may slip

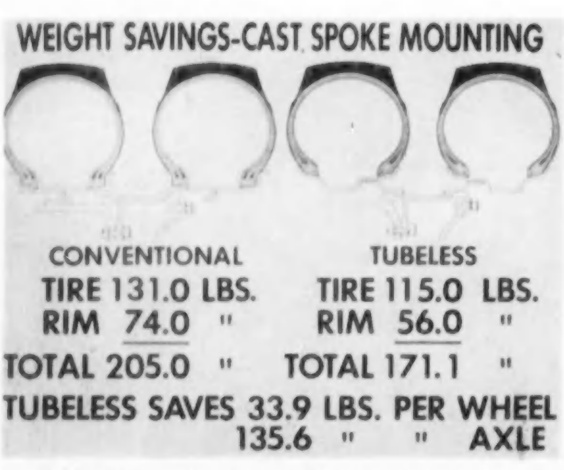


Fig. 5—Weight comparison for conventional tire and rim and drop-center tubeless tire and rim (cast spoke mounting).

Fig. 6—Weight comparison for conventional tire and rim and drop-center tubeless tire and rim (disc wheel mounting).

off when the tire flattens, thus creating a hazard on the road.

With the drop-center rim, of course, there are no parts to become bent. If the tire is improperly mounted it cannot be inflated. If the rim is cracked the tire will not hold air.

Weight Savings

Weight savings (Figs. 5 and 6) come both from the tire and the 15-deg tapered rim. A large portion of the tire bead resting in back of the conventional high flange has been eliminated. Our one-piece rim obviously requires less metal than the three-piece rim. Lighter weights mean increased payloads.

On Large Trucks

Because the tire sidewall has been shortened, some difference of opinion exists as to whether the drop-center principle can be used on large truck tires. In Fig. 7 compare section heights above the tops of the rim flanges for the conventional and drop-center tubeless tires. Although the base of the bead has been raised to provide for the drop-center well, the actual height of the tubeless rim flange is greatly reduced. The difference in effective length of sidewall is thus minimized. In fact, our tests indicate that the tubeless has better flex-fatigue resistance than the conventional tire.

Note in Fig. 7 that both tires have approximately the same outside diameters and cross-sections and the same inside rim diameters. The drop-center tubeless tire and rim, therefore, can be mounted over existing brake drums and wheels.

In our opinion, the drop-center principle can be applied to all tires up through 11.00. Actually, 95% of the tire industry's production is in this range.

The remaining 5% is significant, however, since this group includes the large and expensive off-the-road types. Mainly to ease tire changing, we recommend multi-piece gasket-sealed rims for this group.

Improved Ride

With the drop-center rim, the tire cords no longer abruptly change direction at the point where the tire leaves the rim. Stresses are reduced in the lower sidewall region of the tire. Smaller beads are used. The lower sidewall region becomes more flexible, therefore, resulting in an improved ride.

One way to measure ride is to compare spring rates (Fig. 8) for conventional and drop-center tires. Spring rate is the rate at which load must be applied to distort the tire beyond its normal deflection. A more flexible tire has a lower spring rate (acts as a softer spring). The tubeless tire in Fig. 8 has an 11% softer spring than the conventional tire.

Better ride means less driver fatigue and less truck maintenance. Maintenance is reduced since an improved ride indicates that the tires, rather than the truck, are absorbing road shocks.

Safety

Nailed tubeless tires have been run for more than 8000 miles with no air loss. Punctures can be re-

TUBELESS VS CONVENTIONAL TIRE AND RIM ASSEMBLY

Fig. 7—Cross-section of conventional truck tire and rim with drop-center tubeless tire and rim (dotted) superimposed.

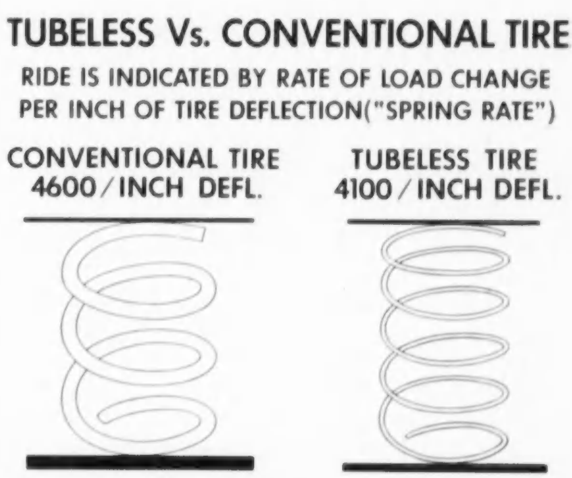


Fig. 8—Comparison of spring rates for conventional and drop-center tires.

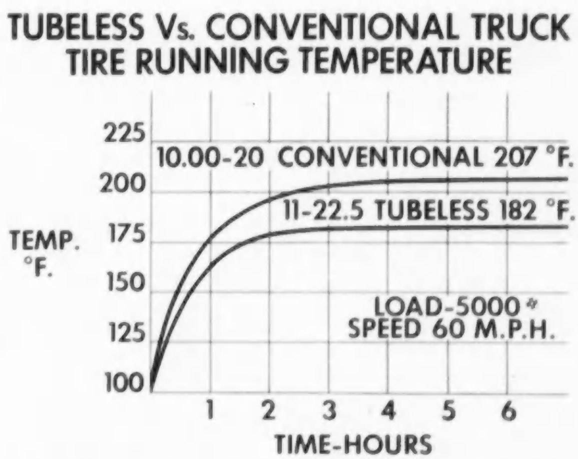


Fig. 9—Comparison of tire temperatures at 60 mph for conventional and drop-center mountings.

paired by filling the hole with gum and applying a small patch to the inside of the casing.

One cause of blowouts is weakening of the tire body by heat. The drop-center tubeless reaches its maximum temperature in a shorter time and runs at a much lower temperature (Fig. 9) than the corresponding conventional tire. This is due partly to the elimination of friction between the tire and the tube (since the tube has been removed). Also, the increased clearance between the rim and brake drum provides additional area (which is not insulated by a tube or flap) for heat transfer through the rim base.

Heat considerations have limited the thicknesses of the tire body and tire tread. The lower operating temperatures of tubeless tires offer new design possibilities as well as longer tread mileage, greater durability, and increased safety.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Goodyear Tubeless Truck Tires—continued from page 48

rims. Other styles of tubeless tires, however, may prove impractical below a certain rim size.

Tire and Rim Design Remain Conventional

The passenger car industry converted to the tubeless without changing the design of either the tire or the rim. In the airplane industry, the conversion to tubeless was made with minor changes in tire construction but with no changes in rim design. Both industries report highly successful results.

In our opinion, the Tru-Seal tire retains all the proven principles of conventional tire construction and rim design. The channel-type section of our rim is one of the strongest yet invented. The side flange and locking ring have each withstood the test of years of satisfactory performance on the conventional tire.

Fig. 3 compares the Tru-Seal and drop-center designs. Note that the drop-center approach reduces the tire section height by 11% and the section width by 3%, shortens the flexing zone, and changes the bead construction. The Tru-Seal design, however, retains the characteristics of the conventional tire. Thus, the satisfactory performance and behavior characteristics of the conventional tire should be retained by the Tru-Seal tubeless. The data on section height and section width are averages of recommended Tire & Rim Association standards for tubeless sizes of 7.50, 8.25, and 9.00. Tire section height was measured from the base of the bead to the tread.

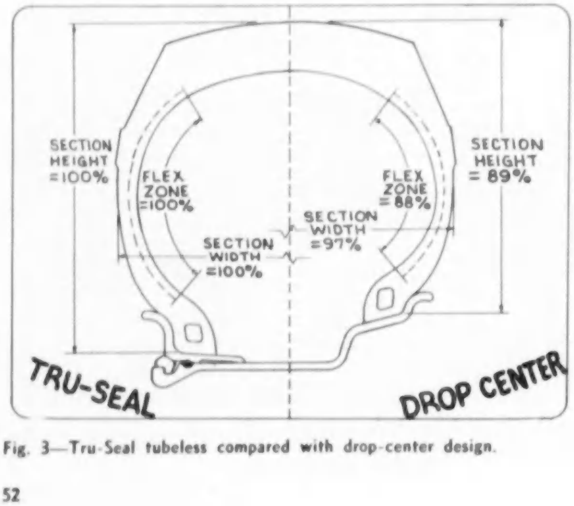


Fig. 3—Tru-Seal tubeless compared with drop-center design.

Performance

Testing the Tru-Seal rayon-nylon tire at 50% overload resulted in no gasket trouble and no pressure loss. After 50,000 miles at 45 to 50 mph the tire carcass was undamaged. No bead troubles were encountered. Running temperatures averaged up to 25 F less than with conventional tires. In shock tests at 45 mph (with impacts 25 to 30 times greater than usually encountered on the highway) the pressure remained constant.

In tests at −47 F the sealing properties of the gasket remained unaffected.

Changing from Conventional Tires to Tubeless

Tru-Seal rims take the same cast spoke and disc wheel mountings as are presently used for conventional tires. No wheel modifications or adapter rings are required.

Modifying conventional rims for other types of tubeless tires may prove costly. Also, the narrower rims required for other tubeless designs may be expensive in terms of performance and dependability.

Maintenance

The sealing gasket may be replaced without removing either the tire, the side ring, or the locking ring. First, remove the rim assembly from the wheel. Now deflate the tire. By standing on the side ring and forcing the tire inward, the sealing gasket may be exposed and removed. The sealing property of the gasket is unaffected by its removal and reinstallation.

Once the tire is deflated only a screwdriver is needed to loosen the locking ring. Of course, tools are required to loosen beads frozen to the rim. (In our experience, all forms of conventional and tubeless tires are about equal in this respect.)

Using no tools, mechanics have mounted our tubeless tire in less than 30 sec (not including the time for inflation). The locking ring is constructed such

that the rim assembly will not hold air if the ring is improperly installed.

Considering all factors, we believe the jobs of dismounting and mounting the Tru-Seal tubeless tire are easier and faster than for any other tire, either conventional or tubeless.

Weight Savings

Table 1 lists weight savings for the tubeless. These figures do not include the rim since even conventional rims of the same size differ in weight. Each truck manufacturer can make his own analysis based on the weight of his present rim. Total tire weight and cost for the Tru-Seal design are about equal to those of any other type of tubeless construction.

Safety Characteristics

The general advantages of tubeless tires over conventional tires are quite numerous. Flat-tire and blowout protection means more time on the road. Puncture repairs at the end of the run may be made quickly and easily. Cooler running temperatures mean improved tire performance and longer wear.

Table 1—Potential Weight Savings with Tru-Seal Tubeless Truck Tires

SIZE	Weights, lb: Conventional tire, tube, and flap	Tru-Seal tubeless tire	Potential savings
7.50-20/8	65.0	57.3	7.7
8.25-20/10	84.1	75.5	8.6
9.00-20/10	105.4	93.8	11.6
10.00-20/12	132.9	118.3	14.6

Eliminating the tube and flap means eliminating difficulties in mounting and centering the tire. Also, tube and flap chafing is no longer a problem.

Ultimately, the cost-per-mile will probably prove to be the biggest advantage of the tubeless tire over the conventional tire, tube, and flap assembly.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Discussion of Drop-Center and Tru-Seal Tubeless Tires

A. W. Bull, U. S. Rubber Co.: In the drop-center design, the inside and outside diameters of the tubeless tires and rims must be the same as the conventional tires and rims which they replace. This requires cutting off the tire sidewall to compensate for the depth of the drop-center well. For example: the distance from the edge of the tread to the base of the bead on an 8.25-20 tire is 8.85 in., while in the drop-center replacement tire it is only 7.60 in., or 14% less sidewall. Both the conventional tire and its drop-center replacement are supposed to carry the same loads at substantially the same deflections. Therefore, the shorter sidewall of the drop-center tire will have to withstand sharper bending than the longer sidewall of the conventional tire. Our tests indicate this will result in an increase in tire failure unless the tire fabric is improved.

T. A. Robertson, The Firestone Tire & Rubber Co.: You can measure sidewall length either from the base of the bead or from the top of the rim. At Firestone, we measure sidewall length from the top edge of the rim flange. In regard to performance of the drop-center tubeless, some changes in tire construction were included in our design to compensate for the shorter sidewall. With our tubeless properly fitted on its rim, we have found the "flex" performance to be better than the conventional tire.

S. Y. Berdon, Aluminum Co. of America: How can a damaged bead on a tubeless tire be repaired?

T. A. Robertson, The Firestone Tire & Rubber Co.: Damage to the bead, which affects the air seal, is a serious problem in any tubeless tire. The wide tapered seat of the drop-center design minimizes the possibility of air leaks due to minor bead damage caused by tire irons. In the event of major damage to the bead, install a tube and flap in the tire.

C. R. Case, The Goodyear Tire and Rubber Co.: In the Tru-Seal design, most of the sealing is done between the bead and the tapered seat. There is little saling against the flange, which is most subject to minor damage. One of the advantages of our design is that a conventional tube and flap can be used in a tire which can no longer function as a tubeless. With the drop-center type, a special tube and flap would be required.

P. G. Hykes, The Budd Co.: There is room for both these programs. Each is a real advancement into more trouble-free and economical transportation. Neither program alone appears to be the sole answer. Time will tell where each fits in.

It looks to us as if the drop-center design is aimed at the high volume tire market and is apparently most economical when its rim is mounted on a disc wheel. The adapter ring required for the use of the drop-center rim on cast wheels presents a cost, sealing, and weight problem. Trucks of a capacity up to and including the usual 18,000-lb maximum axle loading appear to be well served by this design.

The Tru-Seal tire and rim is a universal design and as such is not pointed at any particular segment of the industry. While readily adaptable to disc wheels, it is also interchangeable on existing cast spoke wheels. Its use of proven designs in tires and rims appears to more than offset its increased number of rim parts.

The deciding factor in any final choice of the type of tubeless tire and rim to be adopted for any

particular truck application should be on an overall cost per ton-mile basis.

William Denton, B. F. Goodrich Co.: The Standards Committee of the Tire and Rim Association agreed on June 14, 1955 to approve a technical standardization program that provides for tires to be made as follows:

"Tubeless truck-bus tires in 11.00 and smaller sizes will be designed for mounting on the new one-piece drop center rims for all types of regular and special service."

"Tubeless truck and off-the-road tires for 12.00 and larger sizes will be made with 5 deg taper bead seats to be mounted on multiple-piece rims with sealing gaskets."

Thus, both types of tubeless truck tires will be used but in different size ranges. This standardization will now make it possible for all manufacturers to proceed with tooling for volume production. This is a long step forward in bringing to the truck industry the advantages of tubeless construction for all sizes of truck-bus and off-the-road tires.

Tires for specialized application such as high load, low platform trailer, and farm tractor operation will continue to be used with inner tubes pending the outcome of further development on tubeless tires for these services.

Conventional truck-bus, and off-the-road tires will continue to be manufactured by the industry for use with inner tubes.

Tubeless truck tires for the small and large size ranges will be available only in very limited quantities for additional tests and evaluation by truck operators, in the near future.

Blast Cleaning . . .

. . . is coming into wider use in steel mills because it can do surface conditioning jobs better and cheaper. In many instances it can reduce or eliminate acid pickling.

Based on paper by **J. H. Jones,** Republic Steel Corp.

BLAST cleaning is being used for surfacing sheet for galvanizing, descaling billets, cleaning bar stock for cold drawing, removing scale and oxidation from structural shapes so that paint will bond more tightly, cleaning sheets to provide more suitable surfaces for paint adherence, and for etching rolling mill rolls to provide different finishes.

While blast cleaning is not new to steel mills, wide application apepars to have awaited the development of a suitable abrasive. Prior to World War II, the only abrasive available was a very hard chilled iron product, brittle to the extent that minute particles would embed in the surface of the blasted material. This caused high consumption of abrasive and excessive destruction of blasting equipment. After the war came a better abrasive in the form of a heat-treated iron, and still more recently a high carbon cast shot has been available. The latter has eliminated embedment and lowered costs through reduced consumption and destruction. It wears instead of breaking down and can be used from five to seven times as long as chilled iron abrasive.

Titanium hot-rolled strip and semi-finished cold rolled annealed strip have been cleaned satisfactorily for cold reducing in a shot blast unit using 0.017-in. shot. This mechanical cleaning appears desirable in contrast with caustic pickling. No caustic at all is required for the hot-rolled strip. With semi-finished strip where a caustic dip is necessary, a prior shot cleaning greatly reduces time in the bath. Too much time in a sodium hydride bath results in excessive hydrogen absorption by the titanium.

Stainless sheets are produced from two sources—slabs which are rolled into strip and sheared, or by direct reduction of slabs to sheet bar and then into hot sheets. In our plant which produces high quality stainless sheet from sheet bar, surface defects are removed by blasting number G-80 angular metallic grit, using a hand-operated air blast equipment. Defects not removed by blasting are hand ground. For every 1000 sq ft of area cleaned, 24 lb of grit is consumed.

The basic types of stainless steel—straight chrome or AA, and chrome-nickel 18-8—require different treatment during descaling. For the AA type the process is: box anneal. scale break, breakdown pickle or blast clean without scale breaking, acid dip, and rinse. The 18-8 is continuous annealed, water quenched and dried, blast cleaned, acid dipped, and rinsed. The first operation of scale breaking on AA is primarily to loosen scale prior to pickling. It s often a separate operation entailing extra handling costs. Shot blasting does both jobs in one operation and also provides the proper surface for cold reducing. Elimination of scale breaking contributes about 50% of the savings attained and acid consumption is materially reduced because only a dip in light solution is required.

Overall blast cleaning cost has proved considerably lower than anticipated. Surface conditions have been improved through better removal of defects such as scabs and slivers. Furthermore, dust from blast cleaning can be remelted and returned in ingot form, whereas disposal of spent pickle liquor is difficult.

The blast cleaning unit has been found to be a flexible handy salvage tool for use on critical analyses that sometimes develop excessive hot-rolling defects. (Paper "Blast Cleaning in Steel Mills" was presented before Division XX—Shotpeening of the SAE Iron and Steel Technical Committee, Hot Springs Va., Sept. 28, 1954.)

Measuring Combustion Chamber Volume

Using Air as the Measuring Medium, We Can Now Determine Combustion Chamber Volume Within ± 1%

G. A. Weinert, Ford Motor Co.

Based on paper "Pneumatic and Sonic Measurement of Combustion Chamber Volume" presented at the SAE Golden Anniversary Summer Meeting, Atlantic City, June 14, 1955. Paper will be published in full in 1956 SAE Transactions.

THE VOLUME of a combustion chamber and carbon deposits can be measured with excellent accuracy by using air as the measuring medium. Conventional methods, using a liquid, take more time, are inaccurate due to entrapped air, and contaminate the deposits. There are two techniques of using air for volume measurement: (1) sonic (or dynamic) and (2) pneumatic (or static). The latter "dry" method is particularly useful for measuring extremely small volumes such as carbon deposits.

The Sonic Method

The idea of using air instead of liquid as a measuring fluid is not new. But the most recent innovation has been the development of instruments that can measure volume by sensing air pressure which is periodically varied in a combustion chamber. The frequency of oscillation is then compared with that of a known reference volume and the chamber volume deduced.

Fig. 1 shows a simplified schematic of the method. A jet of air (or an acoustic transducer) in the spark plug opening starts the air in the chamber oscillating. The sound produced (100 to 300 cps, depending on the throat dimensions and the chamber size) is picked up by a microphone and is filtered, amplified, and shaped into a series of square voltage pulses. An electronic counter then determines the number of pulses occurring in 1, 10, and 100 sec intervals.

If resonant frequency is plotted against the volume of a chamber using a fixed throat size, constant leakage factor, constant temperature, and constant

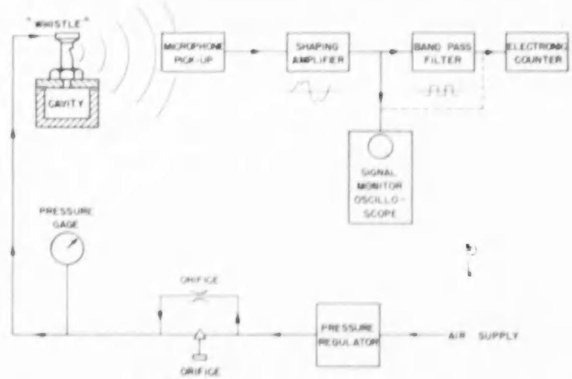


Fig. 1—The sonic method measures volume by sensing the resonant frequency of the air in the unknown cavity. It is compared with the frequency of a known reference volume and volume is deduced.

Measuring Volume with Liquids

MEASURING the volume of combustion chambers and the amount of deposit buildup in them has become increasingly important as engine compression ratios have increased. One method—measuring the amount of liquid that could fill a chamber—does not give satisfactory volume measurements because:

(1) Air may be entrapped. To avoid air pockets the engine cylinder heads must be removed, top dead center located, ring gap sealed, and the unventable parts of the chamber filled with clay. Actual clearance volume must be determined by adding the measured residual clearance volume to the volume of the clay.

(2) Carbon deposits are contaminated by the liquid and the clay, and some are lost in the quench area.

(3) Accuracy is limited due to the small size of the deposits and the tendency of the liquid to stick to the walls of the measuring burette.

This article describes two alternate ways of measuring volume more accurately.

dissipation or energy loss, the results would be as shown in Fig. 2.

In the measurement of actual combustion chambers, however, neither leakage or energy absorption are constant values. Leakage produces a positive frequency shift; carbon deposits increase the energy dissipation of the system and produce a negative frequency shift. To determine the amount of frequency shift under realistic conditions an actual engine cylinder was used with the results shown in Fig. 3.

In practice there is no need to prepare curves or tables relating frequency and volume. Precision volume wafers are added to the reference cavity until its volume is within one cc of the combustion chamber being measured. Over a one cc range the difference in counter readings is then nearly a linear function of the volume difference between the chamber and reference cavity.

In using cylindrical reference volumes care must be taken to correct to the shape of the combustion chamber. Shape sensitivity is due to the change in the effective length of the exciter throat due to differences in the rate of change of cavity cross-section in the region adjacent to the exciter in the combustion chamber and the reference master. After once being established (by independently determining the chamber volume) the shape correction factor is constant for a specific design.

The sonic volume comparator under ideal conditions can sense volume changes of $\pm$.02 cc. A temperature sensitivity resulting in a volume error of approximately 1% exists for every 5 F difference between the combustion chamber and the reference chamber. So time must be allowed for the temperatures to equalize.

In spite of the great potential accuracy of comparing volume by acoustic resonance, frequency shift caused by cylinder leakage and carbon deposits make it difficult to determine volume with better than 1% accuracy. When the precise amount and density of carbon deposits is sought, this is not accurate enough. Pneumatic or static volume measurement is required.

The Pneumatic Method

The pneumatic or static method measures volume without using resonant chambers. A definite weight of air is added to the unknown cavity. The pressure change is then proportional to the volume if the temperature of the air remains constant.

For example, an unknown volume V_x (Fig. 4) can be determined by subtracting a definite weight of air from V_x and measuring the pressure of this gas in a chamber of known size, for example, V_y. Thus, if the pressure P_1 in V_x is initially greater than pressure P_2 in V_y, a definite weight of gas W_1 could be transferred from V_x to V_y. W_1, initially occupied V_x at a partial pressure equaling P_1–P_3. Applying the equation of state for W_1 pounds of gas at a partial pressure equaling the difference between the initial and final pressures in V_x, allows a direct solution for the desired unknown volume V_x if the temperature T_1 remains constant.

One of the problems of previous pneumatic volume measuring instruments has been internal tem-

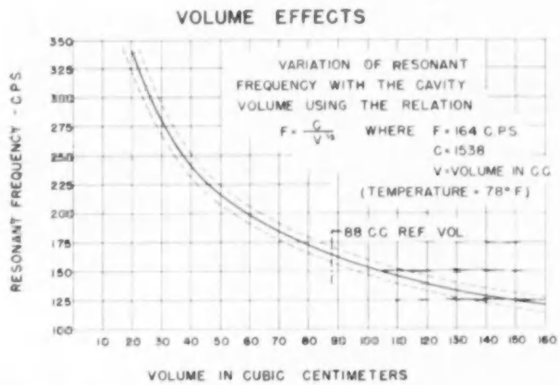


Fig. 2—This shows the effect of volume on resonant frequency using a fixed throat size, constant leakage factor, constant temperature and constant energy loss. Air temperature changes shift the basic curve as indicated by the dashed lines.

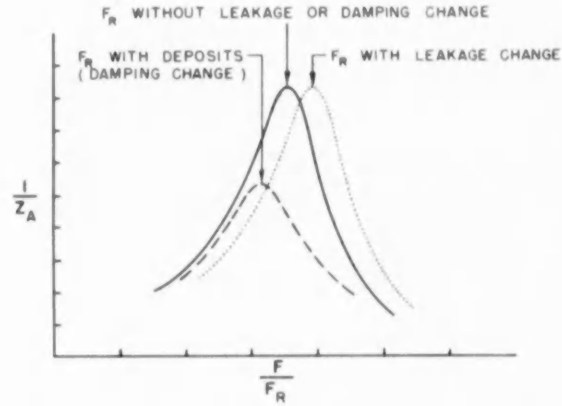
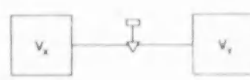


Fig. 3—Leakage produces a positive frequency shift and carbon a negative frequency shift. Cancellation may take place and give a false impression of possible accuracy of volume measurement. Legend: F, applied frequency; F_R, resonant frequency; Z_A acoustic impedance.

perature changes due to the compression of the air in the system. Note that in the process described above the expansion that takes place is thermodynamically a constant enthalpy throttling process. Temperature change is practically zero for gases with low boiling points (air) which expand without doing external work. Thus T_1 in the above process can be considered as a constant.

From the equation for V_x, Fig. 4, a solution for V_x would require the precise measurement of three pressures and one reference volume V_y. A more practical scheme is illustrated in Fig. 5. The space or object whose volume is being measured is placed in series with an arbitrary reference volume V_y. After charging the space or volume surrounding a solid material with air, the supply is cut off and the air allowed to expand into V_y. A sensitive pressure indicator is set to indicate the level of the equilibrium pressure. The process is repeated using a precise master to replace the unknown volume and adjusting the effective size of this master until the same final pressure reading is obtained. Thus by using a strictly comparative process the necessity for precise measurement of both initial pressures (P_1 and P_2) and the reference volume V_y is eliminated. Also the final or equilibrium pressure indicator can be made highly sensitive since it acts only as a comparison gage in which calibration or range is unimportant.

The lower section of Fig. 5 shows the actual pneumatic circuit used in the instrument. The charging pressure is adjustable to any level from 0 to 45 psi. After selecting an arbitrary charging pressure the charging regulator maintains the pressure P_1 to within .0004 psi. The reference volume is actually a bellows loaded on the exterior by an adjustable preload or bias pressure set slightly below the expansion pressure P_3. Air from the automatic pilot valve adjusts the pressure in the small balancing bellows until a force balance exists between the force exerted by the equilibrium pressure P_3 and the sum of the forces due to the bias and balancing bellows pressures. Due to the fixed area ratio of the bellows the gage sensitivity is amplified 59 times greater than its normal value (.05 in. of mercury). The pressure sensing ability of the indicator is in



$PV = WRT$

$V = \frac{WRT}{P}$

WHERE P = PRESSURE
V = VOLUME
W = WEIGHT OF GAS
R = GAS CONSTANT
T = ABSOLUTE TEMPERATURE

$W_1 = \frac{(P_3 - P_2)V_y}{RT_1}$

$V_x = \frac{W_1RT_1}{P_1 - P_3} = \frac{(P_3 - P_2)V_y}{(P_1 - P_3)}$

WHERE P_1 = INITIAL PRESSURE IN V_x
P_2 = INITIAL PRESSURE IN V_y
P_3 = FINAL PRESSURE IN V_x & V_y
V_x = UNKNOWN VOLUME
V_y = KNOWN VOLUME
W_1 = WEIGHT OF GAS TRANSFERRED FROM V_x TO V_y

Fig. 4—Basic theory for measuring volume with compressible fluids using the pneumatic or static method.

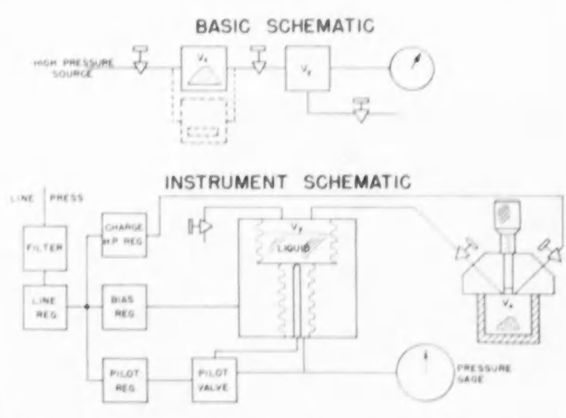


Fig. 5—The pneumatic circuit used to measure combustion chamber volume. Air surrounding the solid unknown volume is allowed to expand into V_y, and equilibrium pressure noted. Then, process is repeated using known volumes until the same final pressure is obtained.

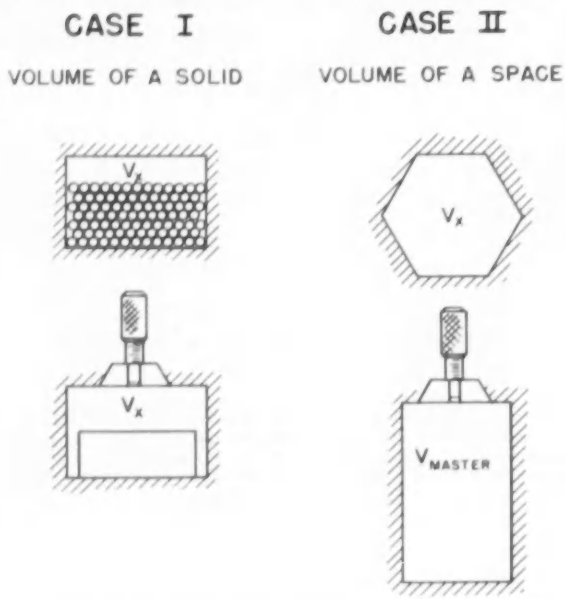


Fig. 6—In case I, solid material is measured by comparing the surrounding space with the space surrounding a precision master volume. In case II, the air tight cavity is measured by comparison with a precision cylinder.

the order of .0003 psi over a range from 0 to 20 psi.

Fig. 6 shows schematically the two basic types of volume measuring problems solvable by pneumatic comparison methods. Case I represents the measurement of a solid material by comparing the space surrounding the solid matter with the space surrounding a precise master. Case II illustrates the measurement of any air tight cavity by comparison to a precise cylinder. The accuracy of measurement is enhanced in Case I by the ratio of the volume occupied by the solid material to the volume of the residual space.

The photograph of Fig. 7 illustrates the pneumatic volume comparator indicator unit, test cavity stand, and precision wafer type cylindrical reference masters. The indicator unit contains all pneumatic circuit components and controls with the exception of the test chambers which are located externally to facilitate design changes arising from special test conditions.

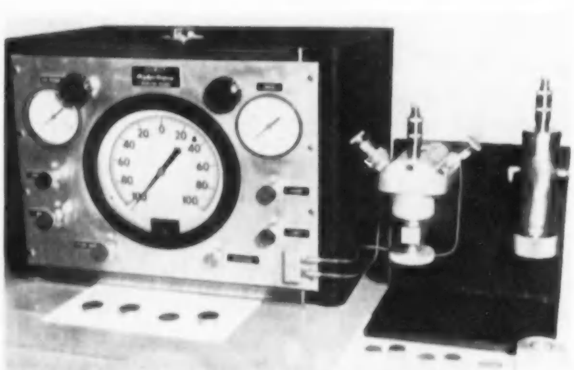


Fig. 7—The pneumatic volume comparator indicator unit, test cavity stand, and precision wafer cylindrical reference volumes.

The basic sensitivity of the pneumatic volume comparator when used to measure a cavity is .01 of 1%, or one part in 10,000. This sensitivity allows high accuracy when measuring small amounts of material such as combustion chamber deposits. We are able to measure easily 1/1000 part of a cc.

Relative Merits of Sonic and Pneumatic Methods

Summarizing the merits of the pneumatic volume comparator and the sonic volume measuring technique, we note the following:

1. Because it uses a dry, low viscosity fluid the nondynamic pneumatic method can measure the volume of any carbon deposits or cavity (without leakage) regardless of size or complexity of shape. When leakage is present (as in combustion chambers) then the dynamic or sonic technique must be employed.
2. The sensitivity of the pneumatic method is equal or better than the sonic method and is roughly 20 times as accurate as the usual 100 cc burette.
3. The pneumatic comparator practically eliminates calibration error since the wafer type volume masters can be checked by means of gage blocks. "Shape" corrections and other restrictions inherent in sonic methods are also avoided.
4. The pneumatic method is especially adapted to the measurement of combustion chamber deposits since the "wetting" and flotation problems of liquid measurement are eliminated and the damping problem of the sonic method is avoided.

The rapidity of volume measurement offered by both the sonic and pneumatic methods so far exceeds conventional techniques that many areas of combustion research requiring volume determinations are opened because of the increased ability to gather data. The typical overall accuracies that can be reasonably expected for the most common applications are as follows:

Carbon Deposits	±.01% (Pneumatic)
Cylinder Head Chamber	±.1% (Sonic)
Combustion Chamber Volumes	±1.0% (Sonic)
Engine Timing (T.D.C. determination)	±.25 deg (Sonic)

(Complete paper on which this abridgment is based is available from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Automatic Transmissions . . .

. . . are proving worth in truck fleets. Operators stress need to put mechanics as well as drivers through intensive training to realize all advantages.

Based on papers by **Walter J. Crocket** Cooper-Jarrett, Inc., **M. S. Hanna** Akers Motor Lines, Inc., **G. H. Maxwell** Hertz Stations, Inc.

FUEL consumption, operating cost per mile, and maintenance costs are reduced with automatic transmissions. This is the experience of operators who have tested out the transmission in truck fleet operations for a sufficient number of miles to arrive at some comparable figures.

Some apprehension was felt over driver acceptance of the "automatics" and there was concern that control of vehicles on icy or snow-covered roads might be less effective. These fears have proved groundless.

Cooper-Jarrett, operating tractor-trailer combinations equipped with GMC twin Hydra-matics on runs between Chicago and New York, reports drivers finding they could spend all their time driving instead of shifting and being able to continue moving on roads that brought trucks with orthodox transmissions to a standstill. Jack-knifing was reduced and so was the dollar cost of damages. Although top speed was lower, this proved to be no penalty. With faster and better shifts, schedules have been maintained and without exceeding company or state speed limits.

Although using units with twin Hydra-matics having a 3 mph slower top governed speed, drivers for Akers Motor Lines have been able to maintain schedules with other tractors having comparable or greater horsepower. Speed on hills is consistently higher because there is less loss of momentum on shifting. And driving under heavy traffic conditions is easier.

Greater safety is one of the advantages all operators have found accruing and it is one that was not anticipated.

Much maintenance and repair work on diesel engines is definitely attributable to driver lugging of the engine. This type of maintenance has been banished with a transmission which presents the right gear at the right time. For this reason, operators believe that added engine life may prove among the real boons. But before it can be stated as a fact, more mileage must be accumulated.

While reporting excellent fuel mileage and general satisfaction with its fleet of 162 Hydra-matic-equipped vehicles, Hertz Stations had 22 out of 28 transmissions fail in one city operation. Investigation revealed the transmission to be running hot. This, in turn, was discovered to be due to overloading because of terrain, something not anticipated in the original study of the customer's requirements. Change from an air-cooled transmission to a water-cooled type, designed for the next larger size truck, ended trouble. From this it is concluded that transmission selection is of primary importance in vehicle selection. It is impossible to use a vastly overloaded Hydra-matic transmission truck in any operation and get away with it. Transmission, engine, and axle ratio are balanced to do a certain job and do it exceedingly well, but one must follow the manufacturer's gvw when engineering these vehicles.

All operators stress the importance of giving mechanics a thorough training. Some place it on a par with driver training; others give it even greater importance. Pioneer operators have suffered for lack of adequate training facilities, but this weak link appears to be in process of rapid improvement.

The transmission is mechanical and must be serviced and adjusted. It won't free an operator from drive-line trouble if he is now careless about clutch adjustments and lacks a preventive maintenance program. Fluid level must be kept at recommended heights; care must be exercised in adding fluid. Both fluid and container must be clean, and filling must be accomplished according to recommendations. The transmission must be drained at intervals and bands properly adjusted when required.

[Papers "Actual Operating Experience and Data of Automatic Transmissions in Heavy Vehicles" (Crocket), "Actual Operating Experience of Automatic Transmissions" (Hanna), and "Effect of Hydra-matic Transmissions on Gasoline Economy and Results in Maintenance Costs" (Maxwell) were presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 17, 1955. They are available in full in multilith form from SAE Special Publications Department. Price: 35¢ each to members, 60¢ each to nonmembers.]

Discussion

W. W. Edwards
GMC Truck & Coach Division

General Motors has invested $32,000,000 in 30 service training centers. These have been opened gradually over a period of two years. We have been able to conduct 170 five-day classes on our four- and eight-speed models and train a total of 917 men. In addition, our mobile training units have conducted 159 classes and trained 1230 mechanics over the past three years.

This does not necessarily fill the bill. We have in excess of 3000 dealers, and experience shows that we should strive for more trained personnel than just one per dealer.

Bringing Dream Cars

BODY engineering begins with the first faint glimmer of an idea in the designer's mind. Throughout all phases of styling, engineering, tooling, and production, the body engineer is constantly evaluating costs, testing components, and solving design problems of all kinds.

Body engineering skills are applied early in the process when the engineer and stylist work closely to establish the optimum size and general proportions of the body. Door hinging, window drop, and structural requirements must be continually weighed in the balance of esthetics and engineering science. Legroom, headroom, and steering wheel-pedal-seat relationships must be determined early in the program by body and chassis engineers for the best in comfort, visibility, and style.

Careful planning is required to integrate the activities of styling, drafting, and cost and tool analysis. Master time and sequence charts, showing time available for preliminary drafting, final layouts, tool studies, tooling, and tool tryouts are drawn and revised almost to the final day of the program.

By the time the idea has come through these preliminary stages, the body engineer is preparing preliminary drawings. These drawings are used by tool and chassis engineers to determine the most economical major stamping arrangements and efficient chassis layouts. Vital tooling considerations, such as the locations of metal joint lines to reduce the amount of metal finish, and the most effective means and methods of assembly in the various plants, are also studied.

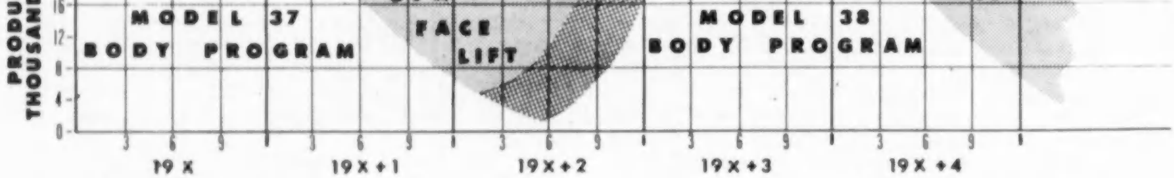
Every aspect of design, tooling, materials, fabrication, and assembly must stand the rigorous test of cost analysis.

Seating mockups, or "bucks," are designed and constructed as early in the program as possible to permit careful evaluation of passenger seating comfort, accessibility to controls, and entrance room.

After preliminary sketches and illustrations are approved, a 3/8 scale clay model is made, which eventually becomes the basis for a full-size clay model. After all changes have been made, a full-size plastic replica of the final clay model is made. This has the exact appearance of the finished car.

Advance draftsmen make full-sized templates from the master clay model for use in preparing advance surface development on vellum. From the advance drawings, the final information is put down

PRODUCTION DRAFTING MANPOWER DISTRIBUTION



LEVELING OUT WORK LOAD PEAKS is one of the problems inherent in drafting room administration. With a fixed design staff, the buildup must be leveled as rapidly as possible. Men must be assigned to the job as fast as information is available from the advance drafting room so that peak manpower requirements can be pulled down and "clean-up" time can be spread out to fill in the valleys between model programs.

J. W. Shank, Chrysler Corp

Based on paper "Body Engineering—Bringing Dream Cars To Reality," presented at SAE Golden Anniversary Passenger Car, Body, and Materials Meeting, Detroit, March 1, 1955

to Reality

on precise metal drafts for use by tool and production men. With the die models, these large aluminum sheets, usually 5 × 11 ft, are the end product of the engineering phase of the body development project.

The body is then divided into its many elements for detail drawings by specific groups assigned to such parts as doors, floor pan, deck and windshield opening, quarters, rear deck, and front end.

In the meantime stress experts have been analyzing all structural sections for strength and efficiency. Weight analysts search for places where weight can be saved. And laboratories test for structure strength.

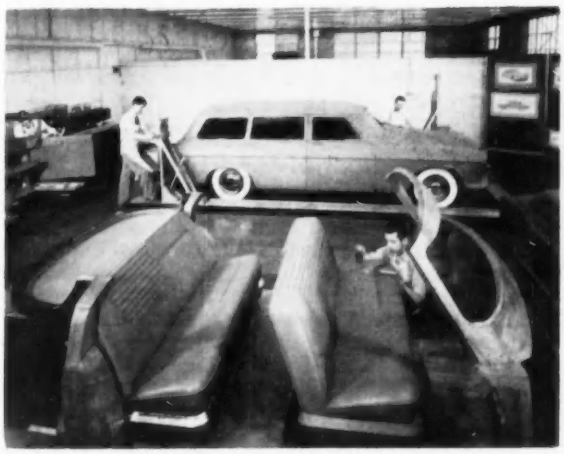
A die model is hand-made in high-grade uniform, kiln-dried mahogany. Duplicates, when required for tools in more than one plant, are made of glass-fiber-reinforced plastic. Toolmakers make patterns from these models from which rough castings are poured and dies are kellered or contour-machined.

As soon as detail drawings are available from the master body layouts, the sheet metal shops begin hand-building parts for assembly into pilot bodies which are fitted to experimental chassis for road testing. This experimental build-up serves another vital purpose: During assembly of the pilot, assembly tools and sequences are set. When the fully painted, trimmed, and ornamented cars complete their lab and road tests, every department has worked together to correct possible faults and to obtain the desired over-all performance and durability.

During the development of the body-in-white shell, a parallel process is developing interior components.

To help the car body resist water, air, and dust leaks, the laboratories are constantly at work on synthetic sealers for internal metal joints and rubber weatherstripping for doors, windows, and deck lids. The body is sound-proofed, too.

Finally, the body engineer follows the body into the production plant to determine that product quality control is being maintained. This includes everything from paint and finish to sheet metal fits, welding, structure, and assembly. With this under control and the new model safely launched, he takes a deep breath, and turns around to find out that he is already six months late on the next model. (Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)



IN THE CLAY ROOM a full size clay model is examined. In the foreground, a clay seating buck undergoes one of many changes before the design is set.

TWIST TEST is conducted in the laboratory to determine proof loading of the body structure. Continual laboratory and road evaluation is necessary so that possible faults are corrected early in the program.

Panel experts

at two SAE National Meetings

give specific suggestions for . . .

More Effective Quality

1. Recognize the capabilities of your machinery.

The ability of a machine tool to produce a desired design is the ultimate factor controlling quality production. Designs and specifications must be set so that machinery and machine operators can meet them with reasonable effort.

2. Control the process, not the product.

Particularly in job-shops where small or medium quantities are produced, good quality control can be achieved by closely watching the operations and making corrections in the processes. When the only way of checking a critical characteristic is by destructive test, then 100% reliability is not possible. However, by proper sampling techniques, use of control charts, and correlation with factors not requiring destructive tests, adequate inspection is possible. In the case of spot welding it is known that 100% inspection can be counted upon only for 85% accuracy.

Generally it pays to inspect in process in addition to inspecting the end product. In this way scrap and defective parts are *prevented* instead of *sorted out* at the final inspection. Final inspection can be simplified, too, by passing on to the final inspector the results of the in-process inspection.

3. Use inspection symbols on your engineering drawings.

To indicate the type as well as the intensity of inspection required for each dimension and the method of measurement, symbols such as these can be used:

Δ Direct
F Fixed
Ω Optical

4. Cross-coordinate management functions.

To get quality production a number of management functions must be coordinated. There are three organizational elements interested in quality control: administration, engineering, and statistics. There are also three functions: setting standards, detecting variations, and locating causes. Each of the three organizational elements is responsible for each of the three functions as shown below.

	Setting standards	Detecting variations	Locating causes
Administration	Economic quality board	Inspection	Know-how Open-mind
Engineering	Tolerances	Measurement	Design of experiments
Statistics	Process capabilities	Histograms Control charts Sampling	Analysis of data

It is interesting to note that inspection is only one ninth the total picture.

5. Hold manufacturing personnel responsible for quality.

Whether production or inspection should be responsible for maintaining quality has long been controversial. Placing the responsibility on the machine operator and shop foreman will put quality into the product at the time of fabrication.

Approximately 15% of the companies represented on the panel have already made manufacturing personnel responsible for in-process inspection.

Approximately 50% of the companies represented are thinking of changing the responsibility from the quality control department to the manufacturing department.

Making the operator responsible for his product

Control

may instill a pride of workmanship. Also, it is possible to prove to the worker that by trying for better quality he will produce more acceptable pieces and will be paid more. Care must be taken that the manufacturing pace is not so fast that pieces of consistently good quality can't be produced. In any incentive plan, management must allow for a certain amount of scrap. Then, using quality control techniques, studies must be made of machinery capabilities, and machinery must be set up properly. This will automatically help the operator produce more and increase his wages.

6. Control quality from top positions.

The higher in the organizational structure that quality control is placed, the more effective the function can be. This reduces the number of organizational lines that must be crossed, and enables management to consult with quality control personnel in many areas such as performance evaluation, design of experiments, analyses of variance, and allowances for stack-up.

The reports on which this article is based are available in full in multilith form from SAE Special Publications Dept. SP-310 includes reports on "Quality Control—An Instrument for Better Management Decisions" and the 7 other panels held at the SAE Golden Anniversary Production Forum, Cincinnati, March 14, 1955. Price: $1.50 per copy to members and $3.00 per copy to nonmembers. SP-311 includes reports on "Taking the Dollars Out of Quality Control without Losing Quality" and the 6 other panels held at the SAE Golden Anniversary Aeronautic Production Forum, New York, April 21, 1955. Price: $1.50 a copy to members and $3.00 a copy to nonmembers.

Quality Control Panels

This article is based on the reports from the secretaries of two panels that were held during SAE Golden Anniversary Meetings:

Quality Control—An Instrument for Better Management Decisions, panel held at SAE Golden Anniversary Production Forum, Cincinnati, March 14, 1955.

Leader: *Leon Bass,* General Electric Co.

Secretary: *H. D. Birch,* General Electric Co.

Members:

Arthur Bender, Jr., Delco-Remy Division, GMC

Warren Purcell, Rath and Strong Co.

Wade Weaver, Republic Steel Corp.

David Hill, Hughes Aircraft Co.

E. E. Schiesel, Mattatuck Mfg. Co.

Max Astrachan, USAF Institute of Technology, Wright-Patterson Air Force Base

Taking The Dollars Out Of Quality Control Without Losing Quality, panel held at SAE Golden Anniversary Aeronautic Production Forum, New York, April 21, 1955.

Leader: *E. D. Bryant,* Fairchild Engine and Airplane Corp.

Secretary: *F. J. Hahn,* Fairchild Engine and Airplane Corp.

Members:

John Bailey, Bell Aircraft Corp.

E. S. Marks, Pratt & Whitney Aircraft Division United Aircraft Corp.

Arnold Johnson, Bendix Aviation Corp.

H. Sims, Sperry Gyroscope Co.

H. F. F. Simpson, General Electric Co.

Kermit Wasmuth, Republic Aviation Corp.

Traffic Engineering

Its Role in Safe and

To be invited to present a monograph in response to a David Beecroft Award is a challenging and at the same time a humbling experience. I am keenly aware of the accomplishments of the distinguished men who presented the eight preceding papers and have admired their scholarly dissertations on important aspects of the traffic safety problem. To maintain the high caliber of the past is a challenge which I approach with humility and yet with enthusiasm.

The distinguished statesman, industrialist and humanitarian, Mr. Paul Hoffman, in the first Beecroft Lecture traced the history of traffic accident prevention, and, in predicting a steady improvement in the record, gave hope for the future. Thomas H. MacDonald, the great road builder, turned the spot-light on driver behavior and related these characteristics to the needs in highway design. The importance of adjudication and enforcement of traffic laws have been brilliantly discussed by Chief Justice Vanderbilt and Franklin Kreml. The dean of safety men, Sidney Williams, has taken us up on the mountain to view our complex world and show us how engineering, government, education, and personal conduct fit into a pattern of organized effort to adapt our modern life to the hazards of mechanized, high-speed movement. And in somewhat more specific areas, Rudolph King has shown the role of the motor vehicle administrator in the control of the vehicle and its driver; Amos Neyhart the place of the educator in teaching safe driving practices and attitudes; and Earl Hall the vitally important role of the gifted man who can, by proper public education, make people "want to have safety."

In this, the ninth Beecroft Lecture, I shall attempt to depict the role of the traffic engineer in highway safety through his efforts to achieve maximum efficient operation of our road and street facilities. If his role is expanded so that traffic engineering can achieve the fullest possible efficiency in transportation, the traffic engineer will be able to make his maximum contribution to traffic safety. In this expanded role, the traffic engineer will have to go far beyond the application of known techniques for the betterment of street use if he is to meet effectively tomorrow's traffic problem. He will have to develop new methods to deal with both old and new problems. He will need more technically trained assistants, greater administrative responsibilities, and better understanding of the complex interrelated problems of transportation, land use, and the community's economy. With mastery of these problems, and when we have achieved the fullest possible efficiency in transportation, we will have made great strides in improved safety as well.

The Urge for Mobility

Beginning with development of the wheel, man's urge has been to ease the difficulties of transport. As man and his goods have become more mobile, the urge has grown to move over greater and greater distances in shorter and shorter lengths of time. And he wants this mobility with complete freedom of movement.

With the advent of the automobile, man attained the greatest individual mobility to date. The motor vehicle is now more than a half century old. During that half century the population of the United States doubled. Most of the increase occurred in urban areas. In 1900, 40% of the population lived in cities—about 30 million people. Today, 64% live in urban areas—the 105 million urban dwellers totaling about three and a half times those of 1900.

Meanwhile, motor vehicles have increased more than 7000-fold. In 1900 there were only 8000 passenger cars and not a single truck or bus. In 1955,

Efficient Operation of Streets and Highways

by D. Grant Mickle, Director, Traffic Engineering Division, Automotive Safety Foundation

This ninth SAE Beecroft Memorial Lecture will be delivered at the National Safety Congress at Chicago, Ill., on Oct. 17, 1955.

there are over 58 million vehicles, including some 10 million trucks and buses. By far the greatest percentage of these vehicles are owned and operated in or from cities. However, during those 55 years, although cities have expanded in area, relatively little has been done to provide the kind of facilities, for movement and for terminal convenience, so obviously needed for efficient motor vehicle use.

The "Traffic Problem"

From all this has emerged what the average citizen, the businessman, and the transportation authority speak of as the "Traffic Problem." A moment's thought makes clear that actually the so-called traffic problem is the sum of several problems. The three major problems are: congestion and delay, lack of terminal or parking facilities, and traffic accidents. (The order of their listing is not necessarily in the order of their importance.) Again, each of these problems is composed of a variety of individual problems of varying degrees of seriousness. There is no single answer to any one of the three major problems.

With the incredible growth of motor transportation, these problems have reached such a magnitude that many people have become convinced that the overall traffic situation is all but hopeless. We are reminded, however, that in the history of the American Republic a good many things have looked hopeless. There was a time when very few people would believe that the Panama Canal would be constructed; there was a time when smallpox, diphtheria, and polio were regarded as incapable of being cured or prevented. At the founding of our nation, its continued existence was not given much of a chance; and for a time, World War I and World War II appeared to be disasters this country would never survive—yet all these things have been met and surmounted.

In the traffic field, too, are examples of impressive victories won by the same American energy and ingenuity.

Recently, a statistician figured out that in 1900 the accident death rate in horse transportation was 30 deaths per million miles of travel. Statistics for the earliest years of the Automobile Age are lacking, but we know that in 1925 the motor vehicle death rate was 19 per 100 million vehicle miles of travel. Just before World War II the death rate hovered between 11 and 12. Since then, the rate has been brought down steadily, reaching an all-time low of 6.4 in 1954. Even with this low rate, there were 36,000 deaths. Still, had the 1925 rate continued with the 1954 travel volume, there would have been a loss of 106,550 lives. This, in effect, represents a saving of 70,550 lives in one year alone.

This drop in the death rate didn't just happen. The achievement was the result of an aggressive, unified attack, in which *proven*—and I emphasize that word "proven"—traffic safety techniques were applied. These techniques brought to bear not only the full force of engineering, but also the resources of education and enforcement. They involved close cooperative planning and action by highway and traffic officials, vehicle administrators, educators, the police and courts, and the public itself.

All are agreed that there is room for vast improvement in the traffic accident situation. Yet,

the American people can look with some satisfaction on a record which shows that within a quarter of a century the fatality rate on roads and streets has been cut to about one-third.

On the engineering side, we know that traffic accidents are often symptoms of faulty road and street design, inefficient street use, inadequate warning and control devices, lack of roadway capacity, poor traffic planning, or a combination of these factors. There is every reason to believe that still greater reductions in accident rate can be achieved when these deficiencies are remedied. With a continuing effort on a complete balanced safety program, we can assume that a rate of three per 100-million vehicle miles of travel can be achieved nation-wide, since there are now five states which have already reached or bettered an enviable record of four.

In dealing with the problems of congestion, delay, and parking, we have available techniques just as sound and proven as those that have been used so successfully in the battle against traffic accidents. Unfortunately, no similar unified attack applying these techniques has ever been undertaken. The question arises: If we know how to cure these traffic ills, then why haven't we done so? There are obvious answers, including cost, special interests involved, lack of leadership, lack of facts, lack of trained technicians, and lack of administrative machinery to cope with this spreading traffic problem that refuses to respect political boundaries.

The demands of today's highway transport have markedly changed the thinking of the administrators and engineers who must provide our roads and streets. In the current philosophy, the highway is not merely a device to permit movement; it is a productive facility, whose output in transporta-

D. Grant Mickle receives 1955 SAE Beecroft Award

Photo by Glogau

D. Grant Mickle

D. Grant Mickle, Director of the Traffic Engineering Division, Automotive Safety Foundation, will receive the Society of Automotive Engineers' Beecroft Memorial Award and present the 1955 Beecroft Lecture (which begins on page 64) on Monday, Oct. 17, during the National Safety Congress in Chicago.

Mr. Mickle has a national reputation in the traffic engineering field, having served as adviser or director for traffic surveys in a number of states and cities. From 1940 to 1943 he was traffic engineer for the city of Detroit. Previous to that he organized the Traffic and Safety Division of the Michigan State Highway Department and served as its first director.

He was Assistant Director of the Michigan Highway Planning Survey from 1935 to 1939 at the same time he was Manager of the Traffic and Transport Department for the consulting firm of Jensen, Bowen, and Farrell in Ann Arbor, Michigan.

Mr. Mickle is a member and past-president of the Institute of Traffic Engineers, and holds membership in the American Society of Civil Engineers, American Association of Public Works Officials, and the American Society of Planning Officials.

Beecroft Award Committee Chairman J. N. Bauman will present the award in recognition of Mr. Mickle's "substantial contributions to the safety of traffic involving motor vehicles" which he has made over a period of many years. The award, which is made annually, originated in a bequest to SAE in the will of its 1921 President, the late David Beecroft.

Previous awards were made to Paul G. Hoffman, Chairman of the Board of Studebaker-Packard Corp. and past-chairman of the Automotive Safety Foundation; Thomas H. MacDonald, formerly Commissioner, U. S. Bureau of Public Roads; Chief Justice Arthur T. Vanderbilt of the New Jersey Supreme Court; Sidney Williams, Assistant to the President of the National Safety Council; Rudolph F. King, Registrar of Motor Vehicles of Massachusetts; Franklin M. Kreml, Director of the Traffic Institute of Northwestern University; W. Earl Hall, Editor of the Mason City Globe-Gazette; and Amos Neyhart, Administrative Head of The Pennsylvania State University's Institute of Public Safety.

This ninth Beecroft Lecture will be published as a monograph by SAE and made available for distribution, as were the preceding Lectures.

tion is measurable in both quantity and quality. The basic objective is no longer to create roads, or even mobility, but the safest, fastest, and most economical transportation possible. Actually, users measure distance today in terms of time rather than in miles as evidenced by the driving time charts on many road maps.

Through the centuries, and into the early period of the automobile, the engineering approach to the highway problem was almost exclusively structural. With the advent of the modern motor car, the functional requirements of the new type of traffic gradually became recognized. Emphasis began to shift from the static aspects of road design to the dynamic factors that bear on free-flowing movement. Opportunities to apply engineering skills broadened to an undreamed-of degree as the volume, speed, and composition of motor traffic generated a welter of complicated new problems.

Since the major part of our key systems of roads and streets was built to design standards prevailing under the old philosophy, it is not surprising that we seem to face a perpetual traffic crisis.

Our existing road and street network was never designed to accommodate the half-trillion or more miles a year which motor vehicles are now rolling up, or to cope with the extremely diversified and complex traffic patterns embraced in this astronomical travel mileage.

Basic Problem is Lack of Capacity

Critical lack of capacity on rural trunklines and urban arterials lies at the root of much of our present highway dilemma. This is apparent from the fact that 87% of all travel on rural highways occurs on roads representing only about 13% of the country's total network. Half of our annual motor travel is concentrated on city streets, which comprise only one-tenth of the total road system. The latter, of course, explains why virtually every one of the 168 metropolitan areas in the nation has become a chronic traffic bottleneck.

Structurally, the bulk of our older roads and streets is still fairly sound. Capacity-wise many of them were already obsolete before World War II.

In the cities, the street capacity problem is usually aggravated by a more or less acute shortage of off-street parking space; in rural areas, it is compounded by a wide variety of design deficiences, including lack of roadside control.

The intolerable waste and inconvenience caused by traffic inefficiencies have served to focus increasing attention on the operational aspects—both in the design of new facilities and in the utilization of existing roads and streets. It has become clear that highway planning, design, and operation are integral parts of the total engineering problem, and that functional principles cannot be ignored without grave jeopardy of the public interest.

Hence, the modern engineering approach strives to keep in perspective the relation of geometric details to the amount, behavior and speeds of the traffic the road must carry. We know that the fullest possible understanding of the desires and abilities of drivers, the characteristics of their vehicles—and the definite limitations of both—are prerequisite to sound construction and operation.

It is factors such as these that have helped to define and shape the several functions now generally recognized as coming under the head of traffic engineering. The traffic engineer's knowledge on such problems must be used more extensively if we are to have efficient and safe transportation.

Traffic Engineering Functions in State Highway Departments

In a modern state highway department today, responsibilities of a division of traffic engineering include the gathering of essential traffic facts, and accident analysis; the review of highway design to insure proper geometric detail; installation of warning and directional signs and route markers; installation of signals at high-volume intersections; and marking of centerlines and no-passing zones. Also within the scope of the state traffic engineer is the determination of speed zones and control of roadside exits.

In addition, the state traffic engineering division frequently provides consulting service to cities and counties within the state, and conducts urban origin-and-destination surveys and studies of parking demand. Traffic engineers have played a prominent part in state-wide engineering studies of highway needs that have been made in some 30 states.

Greatest Need is in Urban Areas

But the greatest vineyard for the traffic engineer's labors is in the cities.

It has been said—without too much exaggeration—that our cities have been trying to make eighteenth century streets serve twentieth century traffic. The gridiron street pattern common to most of our communities, with its characteristic frequency of intersections, was never ideal even for horse-drawn traffic, let alone today's tremendous volumes of high-powered motor vehicles. Add to this fundamental handicap the acute shortage of off-street parking and truck-loading space, and it is easy to see why unsnarling the city's traffic jam is a monumental challenge. Pedestrian conflicts, cross-traffic and turning movements, curb-parking maneuvers, and the mixing of private, commercial, and transit vehicles make congestion and accidents almost inevitable.

A Master Traffic Plan Needed

In this situation, it becomes imperative to make a realistic appraisal of the existing street plant to determine whether or not it is being used to maximum advantage, and if not, how the full service potential of the facilities can be obtained. In cases where main urban arteries are taxed beyond their absolute capacity, the only solution is expressway construction or other capital improvements. But clearly the present street system, by and large, will have to continue to serve for a long time to come. In addition, most of the present street system will always continue its important function of serving the adjacent land, even after through-traffic has been transferred to modern expressways. This leaves no alternative but to find ways and means to reduce physical hazards and utilize available riding surface to the utmost.

A city's traffic improvement program should be comprehensive enough to enable each form of street

THIS is the ninth of ten Lectures by recipients of the David Beecroft Memorial Award, presented annually for "substantial contributions to the safety of traffic involving motor vehicles."

The Award originated in the terms of a bequest to the Society of Automotive Engineers by the late David Beecroft, SAE president in 1921.

Previous awards were made to Paul G. Hoffman, Thomas H. MacDonald, Arthur T. Vanderbilt, Sidney Williams, Rudolph F. King, Franklin M. Kreml, W. Earl Hall, and Amos E. Neyhart.

Copies of this Lecture are available in booklet form from SAE Special Publications Department, at 50¢ a copy to SAE members and $1.00 a copy to nonmembers.

transportation (transit, trucks, and passenger cars) to give maximum service in its own particular field in keeping with public demand, and flexible enough to keep abreast of the city's organic growth.

Such a program is conditional on broad transportation planning. This calls for a careful analysis of all the relevant items in the community—basic transportation needs; inventory of the street plant and its physical condition and operating characteristics; origin and destination of traffic movements; traffic volumes; parking demand and supply; the amount and distribution of housing, employment, shopping, schools, and other major land uses; proposed development or redevelopment; possible changes in population density and in transportation habits; decentralization trends, and so forth.

With the essential facts of street use and transportation needs fully determined and evaluated in the total transportation plan, it is then possible to organize the streets into systems which will best serve the indicated requirements.

Through this process of classification, streets are grouped in accordance with the basic function they should be performing—whether it is to provide access to adjacent property, circulation from one area of the city to another, or through-service. When a street serves mixed purposes, seldom is any one of them well served, and the end product is likely to be congestion and confusion.

Classification provides the basis for the city's master street plan—which, in essence, is the blueprint for implementing the orderly grouping of the streets.

The street plan covers both the physical design and operational improvements needed to bring each system to the level of adequacy for the job expected of it.

The master street plan must, of course, be integrated with overall city planning—serve as its framework so to speak—since traffic is a circulatory system necessary to the location and the mutual relations of the varied community activities.

The plan can exert a powerful influence in defining neighborhoods, stabilizing land values, controlling abnormal decentralization and rectifying the jumbled land uses that have generated so many of the city's headaches. It can do much to aid transit operations and coordinate them more efficiently with other forms of transport.

To carry forward a program of traffic relief in line with these broad plans requires adequate laws, sound administration and above all, public understanding which will lead to acceptance and support. The traffic engineer must play a leading role in obtaining this support and his administrative stature should reflect his abilities to cope with many of these complicated issues.

Traffic Measures for More Efficient Street Use

The recognized procedures of traffic engineering can be used to correct an amazing number of weaknesses in the existing street plant. Not only are these measures, for the most part, relatively inexpensive, but many of them result in benefits which are both immediate and lasting. Some of the techniques have been newly developed; others are adaptations or refinements of practices that predate the automobile, and in some instances go back to ancient times.

For instance, safety islands for pedestrians were already common on the streets of London and Paris in the 1860's. Road markers were used abroad for many centuries, and in America from Colonial days. Our frontiersmen blazed trees or bent saplings to mark their trails, and ancient peoples often piled up stones as trail markers. At the time the "horseless carriage" first became popular in the United States, state route numbers were often painted on convenient barns, bridge railings and telephone poles.

Because the streets of Imperial Rome were narrow and congested, the Caesars established the first one-way movement in recorded history. Parking restrictions go back almost as far, as evidenced by a law in old Pompeii which forbade chariots to stop on the road for loading. In England, regulations of 1660 vintage prohibited the parking of hackney coaches on the King's Highway. Albany, N. Y., passed an ordinance in 1697 to limit the speed of horse-drawn vehicles and horseback riders. While the first traffic survey in this country—a study made in New York to determine customary curb parking distances of motor vehicles—was conducted as early as 1910, the origin-and-destination study is a relatively recent development.

By carrying forward an intelligent and aggressive program of operational measures, many of our cities have substantially increased their street capacity, opened up critical bottlenecks, eliminated recurrent traffic disorders, and reduced their accident rate without large capital expenditure. Proven traffic engineering tools of modest cost that have brought about these benefits include the extensive use of one-way street systems; traffic signal controls actuated by traffic density; reversible lane usage at peak flow periods; curb parking controls; pedestrian supervision; uniform system of pavement marking,

directional, informational and warning signs; and effective routing plans for commercial vehicles and through-traffic.

For example, in one West Coast city, channelization and signal modernization at one important intersection not only relieved congestion, but also reduced accident occurrences 90% the first year following the improvement. Intersection redesign, one-way operation of an intersecting street, signal modernization, and pedestrian controls, reduced accidents from 11 to 3 in one year at a troublesome location in a large midwestern city. Coordination of signals over a section of streets in a southern city cut travel time from 10 to 4 minutes, and also reduced accidents 30% in the first year of improved operation. Examples like this, typical of traffic engineering service, emphasize the point that when the street system and traffic controls are adjusted to provide efficiency, safety is a valuable collateral benefit.

Failure to make more use of operational techniques in many cities can be ascribed to official failure to understand the fundamental importance of street transportation or the extent of the losses engendered by bad traffic conditions.

Most cities spend only a fraction as much directly on traffic-accident prevention as on fire protection. Yet in monetary terms—as well as in total lives lost annually—traffic accidents are a vastly greater menace.

Improved Street and Traffic Management Needed

Another factor which retards development of a realistic program of traffic improvement in many cities is ineffective administration. Certainly, to relieve our strangling communities through freer circulation—in the face of antiquated streets and record-breaking travel volumes—poses a supreme test of sound management. Too often, however, the organizational structure for administering the facilities is as seriously deficient as the street plant itself. Scattered responsibilities, split authority and scrambled organization seem to be characteristic of this vital phase of public administration.

In the case of the older municipal services, such as water supply, welfare, and public works, unity of the managerial structure and centralized authority are provided for in the city charter. Few cities have given charter recognition to street and traffic administration as a major municipal function, with the attention and stature accorded to the long-established departments.

Instead, responsibilities in this area have been parceled out, as occasion arose, among existing city agencies. Such diffusion naturally results in divided powers, duplicated effort, conflicts, and other inefficiencies. Desirable physical improvements, even those of a minor character, may be delayed indefinitely as the proposed project is shuttled back and forth from one municipal agency to another. Moreover, proper correlation of physical improvements and traffic operations becomes a virtual impossibility.

An all-too-common result of this glaring administrative weakness is the failure to make a specific agency responsible for the development, design, and programming of a master street plan. Without a master plan—and the authority to carry it forward—it is hard to budget expenditures prudently for even individual projects, not to mention a comprehensive street program.

Lack of a centralized street and traffic agency also makes it difficult for the city to carry on necessary liaison in highway matters with other jurisdictions. That is an important consideration, since modernization of arterial routes usually demands cooperation of other levels of government—county, state, and Federal. The present setup of most municipal street agencies provides no focal point for effective inter-governmental relations, which of course are essential not only in planning of facilities, but in joint financing, acquisition of rights-of-way, and contract letting.

An encouraging sign is the recent action taken by a few of the larger cities, notably Detroit, New Orleans, and Philadelphia, in consolidating some of the basic functions of street and traffic management. Because of the vital importance to every city's economy, street transportation deserves major attention, and this can best be insured through integration in a single department of those functions pertaining to the planning, construction, maintenance, and operation of the street system. Included, too, should be traffic and engineering surveys, transit routing, street lighting, issuance of permits, and parking. It appears certain that in the future more and more cities will assign these functions to one agency and insure continuity by giving it charter status.

Metropolitan Area Coordination

The rapid growth of suburban sections in recent years emphasizes the need for an area-wide approach in municipal thinking and planning, whether in the interests of improved transportation or other civic objectives. To preserve the economic health of parent cities and foster sound development of the fringe communities will require the utmost in harmonious adjustment of transportation, land use, zoning, traffic laws and controls, administration, and financing. Otherwise, the suburban communities will continue to compound the errors of the past.

In discussing an area-wide approach, the example of water supply furnishes an excellent analogy. The water system of trunk lines, feeder mains, and service lines more than superficially resembles the street system. And both are intended to provide an indispensable service, upon which the public depends, day in and day out, all year long. Moreover, it is imperative that the amount of service be kept abreast of the needs of a growing population. In the case of the water system, this is effected through careful advance planning and unified control over a whole metropolitan area. Not so with the street system. The confusion caused by non-uniform controls, non-continuity of street development, and lack of overall planning are painfully apparent to the motorist though he may not understand the causes. Traffic flows throughout an area with no thought of political boundaries or governmental jurisdictions. Therefore, we must begin to treat traffic problems as we long ago learned to solve our water problem, on an area-wide basis. We should not let outmoded laws, entrenched office holders, or plain inertia deter us from developing a modern governmental structure to deal forthrightly with

the traffic and transportation problems of our great metropolitan areas.

Research

An era of comprehensive traffic research was ushered in back in the early Twenties, when progressive highway administrators decided that the trial-and-error methods and expedients of the past would never provide solutions for the complex problems of motorized movement. A few states, notably Ohio, and several large cities, including Chicago, Pittsburgh, and Seattle, at that time began to assign engineers to the collecting and analysis of traffic facts on a full-time basis. The United States Public Roads Administration (now the Bureau of Public Roads) initiated a series of fundamental traffic studies and several universities undertook similar research. In 1936, the state planning surveys, conducted jointly by the states and Public Roads on a continuing basis, started to build up a vast reservoir of valuable transportation knowledge.

These technical studies brought to the surface many of the underlying weaknesses in the highway transportation system, formerly either overlooked or misinterpreted. For instance, it had been commonly believed that the great bulk of traffic approaching on main rural roads wants to avoid the cities. Origin and destination surveys disproved this, and showed that attempts to relieve urban street congestion by routing around medium- and large-sized cities were by no means the complete answer. It had been assumed, also, that most of the traffic that enters cities was headed for the central business district. Studies revealed that up to 50% of the *downtown* volumes were merely passing through, for lack of more direct distribution routes.

Formerly municipal officials had looked upon street widening as a sort of cure-all for street congestion. Research brought out that the real bottleneck is the intersection, and that merely broadening a thoroughfare did not correct the basic cause of jamming. Moreover, it was indicated that cities which spent substantial sums in widening major streets could have obtained the same or even better results by eliminating the space waste and traffic disorders caused by indiscriminate parking at the curb. It was also found that off-street parking facilities were often cheaper than widened arterials.

Again, in searching for reasons for the preponderance of nighttime accidents, it became apparent that many street lighting systems had been designed with too much emphasis on beautification and too little on safety. Most of the illumination, instead of being directed onto the pavement, was being thrown into the air or used to illuminate the facade of buildings along the street.

New findings revised old theories about the relation of speed to accidents. Setting of arbitrary limits, usually without the advantage of engineering considerations, was having no perceptible effect on the accident curve. Speed in keeping with conditions, rather than a general slow-down of motor vehicles, became a more realistic objective of control—especially since in the public mind the free mobility of the automobile is one of its prime assets.

Similarly, it became clear that misuse of traffic control devices and other regulatory measures was not only wide-spread, but was adding materially to the traffic confusion. It began to be recognized that an unwarranted or a badly-timed signal light, or a poorly-placed traffic sign, could do more harm than good; or for instance that because of unsound routing, the place where transit vehicles must make a turn could become the focal point of a perennial traffic snarl.

In short, the cardinal lesson taught by the factual studies was that efficient traffic operations are impossible without the guidance of tested engineering principles.

Most of the data collected by the state highway department planning surveys were confined to rural roads. In cities, the almost complete lack of similar and equally essential data continues to be a major barrier to more rapid progress in solving our urban transportation problems.

Effective operation of street and transit systems requires the employment of technical information, comprehensively collected and analyzed, and based upon cumulative experience. Likewise, adequate facts are needed for continuous long-range planning and for closely integrating such planning with day-to-day operations. Such facts aid the city planner in developing plans and establishing capital improvement programs related to urban transportation; the traffic engineer in operating the street system to maximum efficiency; the transit operator in providing more effective service; the public works director and the city engineer in designing street improvements and in creating the street maintenance program; and the financial official in the preparation of the annual budget.

Not until municipalities have at their disposal an ample reservoir of these data will they have an adequate means of determining the deficiencies of their transportation systems, of planning realistic programs to overcome those deficiencies, and of presenting clear statements of needs to legislative bodies and the public.

For several reasons, unfortunately, cities have not been able to undertake such data-collecting programs. In general the type and scope of the facts required have not been adequately defined, nor have altogether efficient procedures been developed to collect the information.

Some data, it is true, are available and some collection methods exist. In respect to the latter, however, it frequently is found there has not been sufficient development of the data; dissemination among cities has been far too limited, or present methods of collecting data are too expensive.

Six national organizations, with interests specifically in the urban field, have recognized this lack of essential data, and in May of 1954 formed the National Committee on Urban Transportation. The aim of this new body is to determine which facts cities should collect and to provide standard collecting procedures. The cooperating organizations are: American Municipal Association, American Public Works Association, American Society of Planning Officials, International City Managers' Association, Municipal Finance Officers Association, and National Institute of Municipal Law Officers. Because of the growing importance of coordination between rural and urban traffic planning, the municipal groups invited representatives from the U. S. Bureau of Public Roads and the American As-

sociation of State Highway Officials to membership on the Committee.

Basically, the Committee seeks to develop new and simplified methods to evaluate the existing and potential requirements for moving persons and goods throughout an urban area. Furthermore, the subject of an optimum level of service at which such persons and goods should be moved is being thoroughly explored.

Central to this far-reaching project is an all inclusive inventory of transportation services and facilities. This will cover the physical conditions of the transportation system, the operational conditions of the system, as well as the existing legal tools, financial limitations and possibilities, and managerial structure related to urban transportation. So that the findings of this inventory may be most beneficial, all data, as far as feasible, will be collected and reported on a uniform basis.

After techniques and methods are established initially by subcommittees, pilot studies will be conducted in test cities throughout the country. Procedures then will be revised and refined in light of the pilot projects. Finally, manuals will be prepared and made available to all cities.

Procedures to be set forth in the proposed manuals should permit cities to carry out programs of fact-gathering and analysis, with local forces and on a uniform basis, within the normal framework of municipal administration. The plan is to design simple, economical procedures which will permit studies to be undertaken frequently enough to measure the impact of changing conditions.

Specifically, for the traffic engineer this wealth of basic data will make it possible for him to clearly understand the total urban transportation problem. It will give him the information necessary to evolve compromises necessary to use the existing streets to their maximum efficiency. This information will help him analyze the needs for new traffic arteries and indicate how they should be integrated with the existing street system. Likewise, it will help to coordinate such long-range planning with day-to-day operations.

Interest Grows in Urban Problems

Recently, there has been a great resurgence of interest in the urban problem. Much attention is being focused on the need to renew and rebuild large metropolitan areas.

For example, the National Retail Dry Goods Association has established a Committee on Revitalization of the Downtown Area. This Committee intends to dramatize to the 7500 members of NRDGA throughout the nation the problems which are plaguing downtown districts in most of the cities. A further Committee proposal is to "give advice and counsel where it may be sought, as to what steps should be taken to arrest the trend of deterioration present in so many of such districts."

Another new national organization is made up of citizens concerned with urban renewal. It is called the American Council To Improve Our Neighborhoods—ACTION, for short. It is backed by some of America's leading citizens from all branches of industry and commerce. The organization plans research, promotion and field departments, and expects to give assistance to communities desiring to embark on urban renewal programs.

Still another group is the International Downtown Executives Association, the abbreviated title of which is IDEA. This group is concerned primarily with the shift of business from downtown areas to the suburbs and seeks to combat any threat to retail trade and downtown property values through expert attention to midtown transportation and parking problems.

The economic and social health of our cities demands that we act with dispatch because the need for improved facilities is critical and must be met without delay. At the same time, we simply cannot afford to make mistakes in planning these community and transportation betterments. The collection and use of data to guide current transportation planning is vitally important and must be carried forward with vigor. At the same time, the importance of basic research cannot be over-emphasized for there are vast areas in the urban complex in which our knowledge is deficient. There have been some interesting moves in this direction. For example, the Highway Research Board of the National Research Council appointed a Special Committee on Urban Research, which met in Washington early in 1954. The Committee drew three principal conclusions:

> "First, the importance of cities in the United States from the standpoint of their population, wealth and economic activity places a high priority on the solution of problems standing in the way of a desirable development of urban communities.
>
> "Second, among the many problems of our cities, one of the most important is the provision of adequate transportation. The Committee focused on the transportation aspects of the urban problems, but it emphasized the fact that transportation problems are closely related to the many other problems facing the city, and that transportation solutions must derive from solutions involving the total urban complex.
>
> "Finally, study and action to relieve the difficulties now encountered in urban areas are not commensurate with the plight of our cities nor the urgency of needed remedies."

On the third point the Committee elaborated as follows:

"Research on urban problems is being conducted on a small to modest scale in a number of universities and other agencies, but it is not known how many organizations are engaged in this work and what the nature and scope of activities may be.

"There appears to be no focal point at the national level where a knowledge of what is being done and what has been accomplished is maintained.

"There is presumably no organization dedicated to the dissemination of research findings aimed at promoting a better understanding of the city and its transportation and related problems.

"There appears to be no effort underway to achieve a comprehensive approach to the transportation problems of cities through organized research among all of the many disciplines involved.

"Financial support now being made available to

universities and other agencies attempting to open up new avenues to the understanding and solution of urban problems is *not* adequate."

The Committee recommended the creation of a special organization with two functional parts: technical research, and ways and means of financing the studies. The Highway Research Board is now organizing a continuing project of Urbanization Research.

This type of broad urban research is necessary if the traffic engineer is going to know how he can most effectively integrate the development of the transportation system with overall community expansion. Certainly an approach to the urban transportation problem on such a broad basis is bound to bring greater efficiency to our streets and highways.

Traffic Engineer's Role Broadened

Against the background of phenomenal growth of motor vehicle use and increasing public concern about the inadequacies of present urban transportation, the role of the traffic engineer has broadened immensely. He is no longer merely a sort of glorified "screwdriver mechanic" who installs signs and markings to guide and warn traffic, and times signals to alternately assign right-of-way at busy intersections. Nor is he just a trouble-shooter—the man to whom unusual or controversial traffic difficulties are referred. He is now recognized as a specialist with responsibility for discovering and defining traffic and transportation problems and developing practical plans for their solution—in other words, the technician who makes the street transportation system tick.

By the very nature of the problem with which he must deal, and by the experience gained therefrom, he has become an essential engineering cog in the machinery of providing safe and efficient transportation. The job is complex, involving a myriad of movements for a vast variety of purposes. The quality of transportation has a direct bearing upon shopping habits, retail trade, property values . . . indeed, the entire economy. No single activity has as much influence on the country's economic health as does that of the highway transportation industry. Therefore, our best hope for finding solutions to many of the knotty problems of urban transportation lies with the men whose training and experience are in those areas dealing with: travel desires, characteristics of drivers and vehicles, traffic patterns, travel habits, relation of geometric design to accidents and efficient movement, the effect of land uses upon traffic density, parking, terminal needs and other related matters.

One major challenge facing the traffic engineer is to help in the realistic integration of mass transit and automobile use, so that each may provide maximum service consistent with public desire. Another is to meet the many new operational problems introduced by modern expressways, especially in the urban areas. Coordination of expressways with existing street systems and parking facilities is a jig-saw puzzle of formidable size that must be solved. The characteristics of drivers, intricacies of road and street layout and vehicle design must be taken into account in the interest of safety. Roadside control, safe but not restrictive speed regulations, improvement of nighttime visibility, pedestrian control, equitable regulation of street parking, commercial loading and routing measures, off-street parking, zoning, land use and street capacity appraisal, as well as the more conventional techniques for guiding, warning and directing traffic all must be applied with understanding.

Traffic Engineering Training

The traditional highway engineering curriculum of the past provided little instruction in some of these areas, which embrace not only civil engineering techniques, as well as electrical and mechanical engineering principles, but also economics, psychology, and government. Thus, there was need for specialized training for technicians who would give full time to operational aspects of the highway job and to the related problems of planning and design. First established at Harvard, and since 1938 located at Yale, the Bureau of Highway Traffic has provided graduate traffic engineering training for over 300 engineers, most of whom are now actively carrying on their professions in positions of responsibility in cities and states.

While the post-graduate work at Yale is highly specialized, other universities offer training and research opportunities in traffic engineering along with highway engineering courses. Notable among these are the University of California, Georgia Institute of Technology, Purdue, Cornell, and the University of Michigan.

With a need for specialists to head up traffic engineering units in all cities over 50,000 population and in every state highway department, toll road authority and the more urbanized counties, there is an urgent and continuing demand for these engineering graduates. In spite of the more than 800 members of the Institute of Traffic Engineers, there is still need today for 1200 or more additional, qualified traffic specialists. But in addition, the growing complexity of highway transportation requires that all technicians who plan and design the road and street network, from the chief engineer or director of public works to the chief of design, have understanding of operational principles. The limitations of both drivers and vehicles must be reflected in the geometric design. The understanding of accident causes, requirements of intelligent control and needs for adequate direction of traffic, as well as the techniques for traffic planning, are necessarily a part of the modern highway engineer's training. Therefore, a paramount need in all engineering schools is for more rapid integration of basic traffic operational principles in highway engineering courses.

Because of the urgency of the problem, and in anticipation of a greatly expanded road building program, there is also need for a stepping-up of in-service training for state and city officials responsible for traffic planning, design and operation. Here is an opportunity for providing a real service through the cooperative efforts of state highway departments, leagues of municipalities, and state universities.

A Look Ahead

Looking ahead, we can safely predict that the demand for qualified traffic engineers will continue to rise, as urban highway facilities are expanded

and rehabilitated through the many stepped-up programs that are sure to come. The public will expect full service dividends from the spacious motorways in which they are now investing in growing measure. The super-highways now beginning to thread a few of our chief cities will some day be part of expressway networks that will lace many metropolitan areas. By the same token, the sheer volumes of motor traffic on existing facilities are certain to give impetus to an accelerated effort to operate them as scientifically as possible.

This will involve more productive methods of lane usage and reversal of the direction of traffic during peak periods by signal control. Instead of lane efficiencies of only 20 and 30%, as now experienced on many of our urban arteries, service approaching the high efficiency ratio on expressway lanes will be sought and probably obtained.

More and more, surface arterial streets will be converted to semilimited access facilities by closing minor cross-streets and controlling turns at major intersections. Progressive signal timing, giving preferential treatment to the direction of principal traffic flow at different times of the day, will also be employed far more extensively than at present.

Modern signal-control methods will be a "must" and electronic devices will be used to change signal cycles several times during the day to accommodate shifting patterns of traffic movement. Radar or modified, closed-circuit television may be adapted for use at strategic points to advise a central dispatching office of unusual traffic tie-ups, so that emergency measures can be taken promptly.

Parking on the street will disappear, and off-street parking structures will sprout plentifully in the downtown sections. Mechanical garages will be commonplace; devices for parking vehicles will become just as much a part of business facilities as the elevator and the escalator.

In 10 short years we have seen monumental changes in the central area of such cities as Los Angeles and Pittsburgh. Is it visionary to imagine that another 10 or 20 years may bring even more startling improvements, such as networks of elevated expressways or freeways leading directly to huge parking structures strategically located throughout the business district? Escalators from the parking levels to ground level, which will be devoted to promenades, parks, and store displays, all served by covered, moving sidewalks? Commercial delivery to stores by underground conveyors or pneumatic tubes from fringe truck terminals? These and improvements yet undreamed-of may be conventional in the foreseeable future.

In rural areas, spot treatment will provide extra lanes on steep grades for slower-moving vehicles. Roadside controls will be much more extensive, and signing will be modernized for greater visibility and convenience. With an expanded highway program, we will see rapid development of high-capacity roadways between and through all principal cities.

New-type controls on these modern motorways will bring an even higher degree of safety at high operating speeds. These may take the form of electronic devices to adjust speeds to various conditions of weather or traffic. Density-measuring devices will reroute traffic away from congested areas and warn in advance of traffic stoppages due to accidents or breakdowns.

We are, without question, on the threshold of a transportation era when automotive travel will exceed anything previously visualized. Our present traffic volumes have already far outrun the volumes predicted for 1960. In terms of number of motor vehicles, we are 10 years ahead; in terms of roads and streets, we are at least ten years behind. Since the highway system is the backbone of our civilian economy and our national defense, we cannot afford to lose sight of this fact. It is a matter of vital importance to all citizens. To the traffic engineer, it is both a challenge and a tremendous opportunity. For to serve the nation adequately in the critical years ahead, highway transportation must be technologically advanced to the limit of our capabilities—must be expanded, revitalized and made safer and more efficient than ever before.

Cornering Force . . .

. . . seems to be an inherent characteristic of the pneumatic tire which will be difficult to change greatly by tire construction.

Based on paper by **J. J. Robson,** Firestone Tire & Rubber Co.

THIS is one of the findings of a test conducted to determine the handling characteristics of tires at high speed, using a method which makes a continuous recording of tire temperature and pressures, and the forces acting on the chassis and on certain chassis parts.

Other findings were as follows:

- Self-aligning torque did not drop off at higher speeds at normal slip angles. This tends to contradict previous findings and opinions.
- Self-aligning torque can be improved through tire construction, but probably at a sacrifice in riding comfort.
- Self-aligning torque drops off rapidly at higher angles. However, these are beyond normal turning angles used on the highway.
- Studies thus far show a reasonable correlation with previous work which generally has been done on smaller test wheels at lower speeds.

Certain peculiarities have shown up, particularly in the erratic behavior of the alignment torque. This needs further work now in progress in our study. (Paper "High Speed Cornering Forces" was presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 15, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers. Also, the complete paper appears in the 1955 SAE Transactions.)

West Coast Meeting Notes Gains in

THE SAE Golden Anniversary West Coast Meeting demonstrated vividly that the trucking industry of the Northwest is very much aware of its responsibilities to the general public. The 400 men who gathered at the Multnomah Hotel in Portland, Aug. 15-17, for the event spent as much time discussing regulation of truck noise and provision for dependable braking as they did on maintenance subjects.

Three Busy Days

In six technical sessions the men discussed decibels and deceleration, suspensions and superchargers, stop-and-go service and shop instrumentation, chromatograms and the construction of a plastic body truck driven across the country to the meeting by two young women. Meantime, wives who had come with their husbands enjoyed a drive along the Columbia River, a cruise on the Willamette River, and a tour of a knitting mill, on successive days.

General Chairman of the meeting was Julius Gaussoin. Mrs. C. A. Dillinger was in charge of ladies' events.

The men and many of the wives attended a banquet Tuesday evening, Aug. 16. There they heard Walter W. Belson, of American Trucking Associations, Inc. credit the industry with not only serving the public but making people aware of that service. He said the industry has achieved two positive results in public relations: (1) The public is aware that truck transportation is essential in peace and war. (2) And the public now has a generally favorable attitude toward truck drivers. This was done, Belson pointed out, not by propaganda but by the industry's good practices in driver selection, training, and supervision.

One important objective still to be achieved is to convince the public that "the trucking industry stands on its own feet and pays its own way," Belson said. He remarked also, "One of the major factors in the progress of the trucking industry has been the standardization activities of the SAE." Members were proud to hear, too, from Toastmaster Claire Brown, president of the Oregon Trucking Association: "I want to express the indebtedness of our group to you men of the SAE and your Society. The trucking industry could not have prospered and become the factor it is in our nation's bloodstream had it not been for your help."

Discussion at a technical session left no doubt that the industry is making progress in another field of public interest. Noise, that is. Most new trucks roll off the assembly line with mufflers that hush engine noise to the 125-sone level set by the Automobile Manufacturers Association several years ago. When the original muffler wears out, the truck owner can buy a replacement muffler that will again quiet the vehicle. Not all replacement mufflers can do the job, but there are some adequate replacement mufflers on the market and more on the way.

Tackle Noisiest First

Speaker and discussers agreed that enforcement of 125-sone regulations need not be the bugaboo it has been considered. True, the only portable instrumentation now available measures decibels instead of sones. And the two scales are not convertible. But the situation has improved to the point that we can rely on the enforcement officer's built-in sound-measuring device—his ears. Most modern trucks on the road today operate below the 125-sone level. The occasional vehicle that doesn't is usually a flagrant violator operating at 200 sones or louder due to generally poor maintenance.

Trucks this noisy are easy to spot. Let the enforcement officer present them with citations which require the owner to improve his equipment or prove that it is equipped with mufflers certified to quiet that particular model to the accepted level. Such was the sentiment of participants in the session.

Implied was the warning that any operator present who hadn't done all he could to reduce the noise of his trucks could expect no sympathy from his more civic-minded brethren. A small percentage of noisy trucks can bring down public wrath on the entire industry, it was emphasized.

Muffling, Stopping Ability

Truck operators are just as much concerned that there be safe, reasonable regulations on stopping ability. They listened intently to the news that the Uniform Vehicle Code now incorporates the stopping ability recommendation of the Bureau of Public Roads. Next step is to get the new brake code adopted by the States. Final step will be to see that it is enforced effectively and fairly, they were told.

Swiss Make Brake of Engine

Wheel brakes aren't the only means of decelerating vehicles, meeting participants were reminded. Many European vehicles, particularly the Swiss Postal System busses, turn their engines into compressors to absorb energy and slow themselves. Basically, all it takes is a valve to close off the exit to the exhaust manifold plus a device for cutting off fuel at the carburetor or diesel injector. As the truck's inertia drives the pistons, they pump air into the manifold, absorbing the vehicle's rolling energy. The additional retardation is usually about equivalent to one gear step-down.

For highways to keep pace with advances in vehicle design, said luncheon speaker R. H. Baldock of the Oregon State Highway Commission, there must be a basic highway plan. He urged trucking interests to work with city, county, and state authorities

SAE Councilor J. G. Holmstrom (left) who represented SAE President C. G. A. Rosen at the banquet, SAE Oregon Section Chairman Ray Preston, and Meeting General Chairman Julius Gaussoin.

Banquet Speaker Walter W. Belson and Toastmaster Claire Brown.

in devising such a plan. "Congress could take a lesson from Oregon, which authorized $72,000,000 in bonds to make improvements that are fast paying for themselves," he said.

Maurice Olley, also speaking at one of the daily luncheons, predicted that "If we could get an atomic battery, we might go back to the electrics." At the third luncheon, Capt. Walter Lansing of the Oregon State Police warned that a high proportion of accidents occur at relatively low speeds—where people become lax in their driving habits.

As relaxation after three days of concentration on technical problems, SAE Oregon Section arranged a buffet supper and dance on the final evening of the meeting.

Three days of concentration it was, too, for most of the participants. Even a broken collarbone didn't keep one man from attending sessions. He slipped in getting out of the bath in his hotel room the first morning of the meeting, breaking his collarbone in two places. But by mid-morning he was bandaged up and back at the session.

Eleven papers and two panel discussions made up the fare of the technical sessions. Future issues of SAE Journal will abridge each paper. Complete papers are available now at 35¢ to members, 60¢ to nonmembers from the SAE Special Publications Department.

Highlights of the papers and panel discussions follow:

PROGRESS IN NOISE ABATEMENT—We're making slow but steady progress in quieting the nation's truck fleet. Truck manufacturers have voluntarily adopted a 125-sone standard of maximum allowable truck loudness. Virtually all the new trucks coming off the assembly lines now have mufflers at least as quiet as this standard. Also, the replacement-muffler manufacturers are tooling up quickly to produce mufflers for older vehicles that will likewise meet this standard.

Enforcement agencies still have a problem, however. There's no portable instrumentation for measuring vehicle noise to the sone standard. There is portable instrumentation for measuring noise in decibels, but a decibel enforcement standard would have little relationship to the sone production standard.—**L. C. Kibbee, American Trucking Associations, Inc.**, "A Practical Approach to the Truck Noise Problem"

NEW STOPPING ABILITY REGULATION—The requirement adopted for the Uniform Vehicle Code follows to the letter the recommendation of the Advisory Committee on Brake Research to the Bureau of Public Roads. The requirement is:

Brakes of all vehicles except passenger cars shall be able to decelerate the vehicle at 14 ft per sec per sec. This means the equivalent braking force shall be 43.5% of vehicle or combination weight.

Single-unit vehicles with a manufacturer's gvw of less than 10,000 lb shall stop in 30 ft. Single-unit, two-axle vehicles with a manufacturer's gvw rating of 10,000 lb or more shall stop in 40 ft. All other vehicles and combinations with a manufacturer's gvw rating of 10,000 lb or more shall stop in 50 ft.

Brakes of passenger vehicles, not including buses, shall be able to decelerate the vehicle at 17 ft per sec per sec—which means they shall have an equivalent braking force of 53.0% of vehicle weight. And they shall be able to stop the vehicle in 25 ft.—**C. C. Saal, Bureau of Public Roads**, "A Practical Stopping Ability Regulation"

ENGINE BECOMES RETARDER—Many European trucks and buses supplement their wheel brakes with exhaust manifold braking (or retarding). It's done by adding a shut-off valve at or near the manifold and a means of cutting off fuel to the cylinders. During the exhaust stroke, the piston pumps air into the closed-off manifold, thereby building up pressure. The more pressure, the more braking.

The pressure doesn't build up indefinitely because when both the intake and the exhaust valves are open, some pressure finds its way through the cylinder back into the intake manifold. Also, as one cylinder pumps into the manifold, the exhaust valve of some other cylinder will act as a pressure limiting valve.—**W. E. Meyer, The Pennsylvania State University**, "Manifold Braking for Heavy 'Over the Road' Trucks—A Review of European Practices and Experiences"

TRAILER AIR-BRAKE VALVE—We suggest that you look at the trailer valve, not only as a breakway device, but also as a device to protect against low pressure broken lines.

We recommend that the trailer valve limit the flow of pressure to the trailer to an amount less than compressor production, so that spillage beyond the trailer valve will not deplete tractor pressure more rapidly than the compressor can replace it.

We recommend that all pressure delivered to the trailer reservoir be reserved exclusively for trailer use so that any spillage forward of the trailer valve will not deplete the trailer brakes.—**H. T. Seale, Homer T. Seale, Inc.**, "Air Breakaway Systems for Tractors and Trailers"

LIQUID SPRINGS — Regardless of what we were taught in our youth, liquids are compressible.

If we took an ordinary direct-acting shock absorber and filled it entirely with fluid, the displacement of oil by the piston rod, as the device was compressed, would act as a spring. The oil which flowed through the valves in the piston would supply the necessary damping action.

It may be possible to magnify this damping action by dissipating energy in the liquid itself, it has been suggested. Certain materials when they are severely compressed change from a liquid to a solid or grease, releasing heat. Reconversion to a liquid occurs

only gradually as heat is recovered.—**Maurice Olley, Chevrolet Motor Division,** "Report on Suspensions for Commercial Vehicles"

ONE-PIECE TURBO ROTOR—The Miehle-Dexter turbosupercharger of DeLaval design differs from other turbos in that its turbine and compressor are a one-piece casting. The hub is part of the rotor casting, too, and contains the bearings, which are supported by a stationary shaft.

The turbine has centripetal blading designed for radially inward flow with axial discharge. Turbine inlet guide vanes adjust to suit the different exhaust flow conditions of different engines.

The compressor is more conventional. It has axial inlet flow and radial discharge into the casting.—**Hans Bohuslav and C. A. Jacobson, Miehle-Dexter Supercharger Division, Dexter Folder Co.,** "Supercharging of High Speed Diesels"

STOP-AND-GO DRIVING — Vehicles like pick-up trucks that are used mostly in dense city traffic benefit from spark plugs of hotter ratings than those used for other types of service.

Tests show that when spark plug tip temperature falls below 600 F, deposits form. They can cause electrical shorts. When tip temperature exceeds 1600 F, there may be pre-ignition.—panel secretary's report by **J. R. Schmitt, Standard Oil Co. of California,** Problems Encountered with High-Power-Output Light Pick-Up Trucks Used Mostly in Dense City Traffic Driving panel

SHOP INSTRUMENTS PAY OFF—Repair shop instruments cost money. But if they're properly used, they can save many dollars more than their cost for a fleet. They help mechanics to find and cure vehicle ailments faster. They enable him to condemn only those parts that need discarding. They permit the maintenance department to minimize costly road failures and to conserve gasoline, oil, and tires.—**Wallace Linville, automotive consultant to Los Angeles County Air Pollution Control District,** "Instrumentation for the Shop"

"ON THE SPOT" TEST OF LUBES—"On the Spot" analyses of used heavy-duty engine lubricants give operators a quick, easy check on oil deterioration and contamination. A single drop of oil on a filter paper shows whether the oil is excessively contaminated, whether or not it retains its detergent-dispersant ability, and whether it can still neutralize acids. This knowledge helps operators avoid wasting serviceable oils by arbitrary change schedules. Also, it reduces the danger that oils whose protective properties have been depleted will be continued in use.

The oil spot on the filter paper is called a "chromatogram."—**V. A. Gates, R. F. Bergstrom, and L. A. Wendt, Shell Oil Co.,** "Further Discussion on 'Oil Spot' Evaluation of Used Engines Lubricants"

PLASTIC TRUCK TANKS—Plastic reinforced with glass fiber has found its way into tanks for transporting liquid cargo. These tanks weigh less, resist chemical and electrolytic attack, and last longer. Besides, they can be repaired easily, with no danger of fire from welding or cutting torches.

Plastic tanks do seem to contaminate liquids slightly when the tanks are used for various liquids interchangeably. But this problem is easy to overcome by using a thin stainless steel liner.—**S. S. Wulc, consultant,** "The Development of Reinforced Plastics in Commercial Vehicles"

PLASTIC BODIES ARE EASY TO REPAIR—Body panels of glass-fiber-reinforced plastic are hard to damage and easy to repair—maybe even easier than the plastic fabricators indicate.

They recommend where a fracture is accessible on both sides, that the same glass-cloth and resin treatment be given both sides.

I do not wish to fly in the face of these recommendations made by men who know a lot more about plastic bodies than I do. But I am willing to hazard a guess that there are going to be many repair jobs made on one side only.—**Henry Jennings, FLEET OWNER, McGraw-Hill Publishing Co.,** "Plastic Bodies Can Be Repaired"

NYLON BUSHINGS ARE HUSKY—In one torsion-bar tandem-axle trailer, the eight main hanger bushings and 16 shackle bushings are made of nylon. The entire load of this trailer with all the shocks and vibration that go with hauling the trailer across the country is carried on the nylon bushings.

We understand that the previously used bushing required replacement every 25,000 to 50,000 miles. Some of the nylon bushings have withstood 100,000 miles of service and are still in operation.—**J. D. Young, E. I. du Pont de Nemours & Co., Inc.,** "Automotive Applications for 'Zytel' Nylon Resin"

ENGINE BREAK-IN PRACTICES — Half-load isn't enough for proper break-in of engines. There should be at least a short period of full-load operation during break-in. An automotive diesel benefits from a 3-hr break-in period, starting with idle and applying one-quarter load increments spaced so that the period ends with brief full-load operation.—panel secretary's report by **H. F. Galindo, California Research Corp.,** on Practical Engine Break-In Methods panel

PROGRAM COMMITTEE for the meeting went to work months in advance. Shown here at work in Chairman Julius Gaussoin's home are (left to right) Gaussoin, J. J. Lovretich, C. A. Dillinger, Ray Preston, A. W. Andersen, T. E. Bokemeier, D. M. McGuire, and C. H. Lewis.

TECHNICAL COMMITTEE *Progress*

1955 SAE Technical Board

C. A. Chayne
Chairman
B. B. Bachman
D. P. Barnard
L. L. Bower
O. A. Brouer
G. E. Burks
H. E. Churchill
A. T. Colwell
F. W. Fink
E. G. Haven
R. F. Kohr
W. C. Lawrence
A. G. Loofbourrow
C. E. Mines
E. F. Norelius
Harold Nutt
A. E. Smith
B. G. Van Zee

Winterized Tractors and Grader To Undergo Winter Field Tests

WINTERIZED construction equipment is going to get a work-out by the Army Corps of Engineers this winter in a field-test program at Virginia, Minnesota, according to discussion at the Aug. 30 meeting of Subcommittee XV on Winterization. (Subcommittee XV functions under the SAE Construction and Industrial Machinery Technical Committee.)

The "winterization" will include special fresh-air heaters to heat cold-soaked engines, defrost windows, and warm personnel; plus special cranking motors; insulated cabs; and diesel fluid starting kits. The Engineer Corps will supply winterized tractors of three manufacturers—Allis-Chalmers, Caterpillar, and International Harvester, and an Austin-Western motor grader.

The equipment will operate at the workings of the Erie Mining Co. Beginning probably in January, the tractors will doze trees, brush, and occasionally snow from rocky terrain. Expected average temperature is about 0 F. If past experience holds, there will, however, be several two- or three-week periods of −30 F average daily temperatures.

The field tests are being run by the U. S. Army Engineer Research and Development Laboratory, which will supply operators for the test operation. The Range Mechanical Committee, composed of representatives of the mining companies in the region who operate construction equipment, is also taking an active part.

This interest stems largely from the taconite available in the area. Taconite mining is profitable if the ore can be converted in furnaces on the site to about 60% iron for shipment—and if the expensive furnace equipment operates the year round. If the furnaces function through the winter, so must tractors, graders, and other construction equipment. So winterization of the equipment will be a necessity.

Erie Mining intends to build furnaces on their site to purify taconite. The company expects to employ 2500 workers in the venture throughout the year.

Subcommittee XV has been serving

Continued on Page 99

New Engine Committee Chairman

J. F. GREATHOUSE, Mack Mfg. Corp., has been appointed chairman of the SAE Engine Committee by the Executive Committee of the Technical Board. He has been acting chairman since the retirement of H. S. White the first of this year.

The Engine Committee and its various Subcommittees are currently working on the following projects:

1. New dimensional standards for four-barrel carburetors.
2. Revision of the SAE Diesel Engine Test Code.
3. Method of performance testing oil filter elements.
4. Dimensional standards for distributor type fuel injection pumps.
5. Performance and dimensional standards for small air-cooled gasoline engines.
6. Water pump seal pocket standardization.
7. Dipstick standardization.
8. Dimensional standards of cog timing belts.

J. F. Greathouse

SECTIONS

OCTOBER 1955

Governing Boards . . .

. . . are challenged by the fast tempo of our modern industry in developing meetings and Section activities

Governing Boards today must keep their sights high and their methods flexible, SAE Vice-President for Aircraft Activity James D. Redding told the St. Louis Section at its Golden Anniversary Meeting May 10. Representing SAE President Rosen at this meeting, Redding brought personal greetings from the Society's chief executive and stressed the potency of common problems facing Section officers throughout the country.

The world is changing rapidly, he said. As individual citizens, we seldom realize how rapidly. Our industry and our commerce are now functioning at a fast tempo. Air travel permits one to compress many activities at scattered places into a relatively brief time span. Governing boards must keep this fast tempo in mind when scheduling their meetings and the subjects they select for discussions.

During the next 50 years, he predicted, SAE Sections probably will find little change in their basic responsibilities and assignments. But, he pointed out, they will face a variety of continuing challenges. Among these he noted:

- Keeping the interest of *all* members in mind.
- Developing meetings broad enough to command the interests of all groups, yet specialized enough to bring knowledge to members who represent the major areas of interest in the Section area.

"Both of these are delicate problems," Redding said, "and they are problems which will be faced by all governing boards in the future—as in the past."

The future of America's economic supremacy, Redding said in paraphrase of President Rosen, may soon rest upon the creative ability of our engineers, rather than our rich natural resources as in the past.

So, he concluded, SAE Sections must create the climate which will stimulate creative thinking among their members; the keen urge to seek new knowledge; the sympathetic appreciation of imaginative scholarship.

SAE Represented By 1389 June Grads

NEARLY 1400 SAE Student Branch members have graduated into the engineering world, announces SAE Student Committee Chairman R. L. Kirkpatrick. "These are the tops in prospective members for the Society."

Student Branch members have an insight into the organization of the Society, its aims and policies. They have shared the experience of cooperating with other engineers on all levels. They recognize the value of individual participation in group action.

The names of these men have been given to Section and Group Membership Chairmen in the various localities.

Personality Is Grad's Selection Key

"Very few engineers fail to progress in an organization as a result of inadequate technical preparation. A very high percentage fail in a professional sense for lack of some personal characteristics." **Lee Aldinger**, Research Laboratories Division, General Motors Corp., emphasized this point at a meeting of the SAE Student Committee where, at this committee's invitation, he summed up his ideas on the type of engineering graduate industry is seeking.

Engineers Get Work

Recognition of the engineers' contribution to America's high living standards accounts for the fact that engi-

CONTINUED ON FOLLOWING PAGE

Twin City Sends Out Questionnaire

Gasoline and diesel engines, and the fuels and lubricants to run them, are the topics Twin City members most want to hear about. And when they hear about them, these members from the Minneapolis-St. Paul area prefer speaker and movie combination meetings.

Twin City's Governing Board ferreted out this information via an attendance questionnaire. The survey drew over 120 replies.

Questions were concerned chiefly with preferences in meeting nights and locations, meals, technical topics of interest, and types of meetings. Replies showed considerable interest in improving meetings. Members were generous with remarks and suggestions for the Governing Board.

In response to questions regarding activity in Section committee work, 14 members expressed the desire to join in some part of Section operation.

Beginning Next Month—

Better News About What SAE Sections Are Doing

Starting next month, SAE Journal will bring its readers more interesting, more useful news than ever before about what SAE Sections are doing.

The SAE Journal Field Editors joining us in this new venture are listed below. The names that we have not as yet received will be printed in the November Journal.

The basic aim will be the same as always: To extract from the activities of each Section the ideas, methods, and news likely to be of most interest to members of other Sections. . . . And so to handle this material as to make it of potential value and interest to any reader of SAE Journal.

This new program—pointed at the old aim—is keyed to provide:

1. Better exchange of ideas and information between SAE's 43 Sections and Groups . . . so that good ideas evolved by one Section may see action in other Sections.

2. Better understanding of individual Section activities by the SAE membership as a whole . . . brought about by printing more articles about what Sections are doing.

3. Closer relationships between Sections and Student Branch activities in their areas . . . by printing Student Branch news under the headline of the Section in whose territory the Branch is.

4. As many news and special articles from each Section as can be developed . . . all printed under a prominent headline for the individual Section, along with a list of new members coming into the Section each month . . . and the list of applicants, of coming meetings, and similar data.

P. S. Technical material from Sections papers will receive the same handling in SAE Journal as do National Meetings papers—in every respect. . . . Abridgments of each one will be individually treated in the Journal's technical pages.

Field Editors—1955-56

ALBERTA GROUP
William Fairhead

ATLANTA
Grant F. Jackson

BALTIMORE
Harry T. Cline

BUFFALO
Dudley Losee

CANADIAN
F. G. King

CENTRAL ILLINOIS
Harlan Banister

CHICAGO
Peter P. Polko

CINCINNATI
H. Edgar Pitzer

CLEVELAND
Wilson B. Fiske

DETROIT
W. F. Sherman

INDIANA
Virgil L. Alexander

KANSAS CITY
Henry H. Hart

METROPOLITAN
Leslie Peat
Read Larson
H. H. Wakeland
R. P. Dominic

MID-CONTINENT
C. L. Cotton

MID-MICHIGAN
Gerald W. Colby

MILWAUKEE
J. W. Mohr

MOHAWK-HUDSON
I. L. Barger

MONTREAL
A. A. Larkin

NO. CALIFORNIA
Leigh J. Abell

NORTHWEST
W. L. Hubka

PHILADELPHIA
Murray K. Simkins

PITTSBURGH
W. C. Weltman, Jr.

SALT LAKE GROUP
F. J. Blatz, Jr.

SAN DIEGO
William F. Bunsen

SO. CALIFORNIA
W. E. Achor

SO. NEW ENGLAND
Stanley L. Leavitt

ST. LOUIS
Fred H. Roever

TEXAS
R. N. Jones

TWIN CITY
H. M. Turner

VIRGINIA
Thomas L. Sharp

WASHINGTON
Charles J. Calvin

WICHITA
W. E. Shelor

WILLIAMSPORT
C. Frank Pannebaker

---

neers comprise 80 to 90% of all college graduates employed this spring in many companies. These employers felt that these engineers could progress within the organization; that they possess the potential for professional advancement. Placed at work providing individual stimulus, they felt these men would be assets to the organization.

Personality

Employers consider personality traits, attitude toward the engineering profession, interest in continued self-development, and participation as a student in extra-curricular activities first when selecting a graduate engineer. His success in dealing with other people is a strong influencing factor in professional progress and the success of the activity with which he is associated. Participation in school extra-curricular activities indicates how far an engineer will go on a self-development program.

Self-Help

SAE Student Branch activities offer excellent examples of available opportunities for self-development. Participation in these activities explains a great deal about the operating procedures of professional societies. So, it is an advantage to become familiar with their operation and objectives early in your career. As student leaders in SAE Branches you profit from close contact with faculty advisors. You have the opportunity to meet and discuss engineering problems with leading engineers in the automotive and related industries.

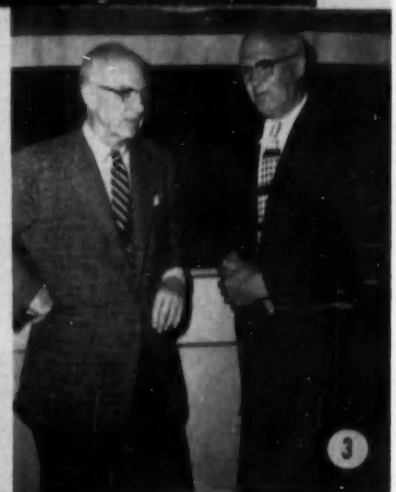
Sections Scan Ideas For Improved Papers

Section governing boards are finding useful the suggestions for getting better papers made by SAE Meetings Committee at its June 15 meeting in Atlantic City.

The Meetings Committee discussed the possibility of improving the quality of technical papers by effecting a closer liaison between individual meetings committees and authors invited to present papers. Meetings Committee members feel that improved communication in this area could achieve better quality papers.

Continued on p. 95

From Section Cameras



1. **ROBERT T. JACKSON**, sales engineer, Perfect Circle Corp., discussed "1956 Indianapolis Racing Car Design" at the Sept. 19 meeting of the **So. Bend Division of Chicago Section.** His talk was illustrated with color slides.

2. **President ROSEN** (center) was featured as guest speaker by **San Diego Section** and **San Diego State College Student Branch** at their combined Golden Anniversary meeting, May 25. He is shown with 1955-56 Section Chairman **C. F. DERBYSHIRE** (left), and 1955-56 Student Branch Chairman **H. DOUGLASS.**

3. At the same meeting, President Rosen chatted with 1945 SAE President **J. M. CRAWFORD** (left).

4. **Northrop Aeronautical Institute's Student Branch** heard an exciting discussion of Flying Saucers at their April 16 dinner meeting. Dr. Heinz Haber (third from left), a member of the staff of the University of Southern California and the speaker, appears here with Student Branch members.

5. The April 20 meeting of the **Northrop Student Branch** featured President Rosen. Student Branch members surround him at the speakers' table.

About SAE Members


Harris


Wolfe


Johnston


Dowd


Proske


Damon


Brown


Wade


Cote


Little


Lowther


Buttner

HAROLD R. HARRIS, recently retired president of Northwest Airlines, is heading a new company, Aviation Financial Services, Inc. This new financial agency has been formed to specialize in the financing of civil aircraft equipment needs.

The exact manner in which the company will function is still being explored, but, in general, it is anticipated that it will seek to arrange financing of aircraft needs of airlines and of companies other than airlines that employ aircraft for general corporate purposes, using the equipment itself as the primary collateral for the financing.

Harris served as chairman of the Aircraft Engineering Display Committee at the 1954 SAE Aeronautic Meeting in New York. He was also SAE vice-president representing Air Transport Activity in 1947.

ROBERT W. WOLFE, chief automotive engineer of New Process Gear Corp., has been named to succeed David H. Brown as director of engineering and research. He will continue the department's growth in engineering and developing passenger car and truck transmissions, transfer cases, and other automotive components.

BRUCE W. JOHNSTON is now serving as sales engineer for Pneuma-Serve, Inc., in Detroit. Pneuma-Serve is a new Cleveland company headed by **GEORGE R. TINNERMAN**, for many years vice-president and director of Tinnerman Products, Inc.

Johnston had served in the same position with Tinnerman Products, Inc.

CHARLES G. DOWD, chief engineer, Detroit Arsenal, Center Line, Mich., has retired as of Sept. 1 after 37 years of service with the Government. He started his career with the Government as a draftsman in the Motor Transport Corps, Washington, D. C. in July, 1917. He transferred to the Motor Transport Service of the Ordnance Corps in 1942.

Dowd has received many commendations for outstanding service and has been instrumental in many of the latest developments of wheeled and tracked vehicles now in use by the Armed Forces.

JOSEPH PROSKE is now defense products engineer with Burgess Norton Mfg. Co. He has been serving as military track engineer.

RALPH S. DAMON, president of Trans World Airlines, Inc., has been named by ASME as the recipient of their Spirit of St. Louis Medal "for meritorius service in the field of aeronautics."

Damon became active in the aviation field in 1922 and by 1932 was president of Curtiss-Wright Aircraft Co. He entered the air transport field as vice president of American Airlines in 1936, but left in 1941 to supervise production of Republic Aviation's P-47 Thunderbolt fighters. He returned to American Airlines as president in 1943, but left in 1949 to head TWA.

DAVID H. BROWN has been appointed assistant general manager in charge of operations at New Process Gear Corp., Syracuse, N. Y. Brown will coordinate and direct the activities of the manufacturing, engineering, and purchasing divisions.

He has been serving in the position of director of engineering and research for the company.

A. S. WADE, who has been sales manager of the Weatherhead Company's Automotive and Ordnance Division, has been appointed to the position of general sales manager of the company's Automotive and Industrial original equipment products, Ft. Wayne Division.

COMMODORE OLIVER H. COTE, JR. is now serving as USN Bureau of Aeronautics representative in Buffalo, N. Y. He has been Head, Engine Research & Development Branch, Bureau of Aeronautics, Washington, D. C.

SHELDON G. LITTLE has been promoted to the position cf assistant chief engineer of the GMC Truck & Coach Division. Formerly the engineer of the GM Styling Section, he will report to **C. V. CROCKETT**, chief engineer of the division.

W. W. LOWTHER has been named vice-president in charge of engineering and industrial sales by United Specialties Co. He has been with the company since Nov., 1953, as sales engineer.

H. J. BUTTNER has been appointed manager of engineering for the Le Roi Division of Westinghouse Air Brake Co., Milwaukee. Just prior to joining Le Roi, he was assistant director, director, and then manager of the Contract Division of Continental Motor Corp. During the past year he has been engaged in a project for the U. S. Army Ordnance.

DANIEL W. LYSETT has been promoted to director of product engineering by Long Mfg. Division, Borg-Warner Corp. He has been with the division since 1942, and was chief clutch engineer previous to his promotion.

R. C. ZEIDLER, formerly director of research and development for Long Division, has become director of research engineering. He joined the company in 1918 and is one of the pioneers in the development of clutches and torque converters.

D. K. WIRTH has been named branch manager of the new Detroit industrial lift truck sales and service branch of Yale & Towne Mfg. Co. Wirth was president of Michigan Materials Handling Corp.

TRAVIS L. GORDY, GILBERT K. LUDWIG, and **ELDON SAUL** are moving with the Continental Oil Co. executive staff to new offices in Houston, Texas.

Gordy, past chairman of Mid-Continent Section, is engineering representative, Technical Services Division. Ludwig is assistant manager of the Technical Services Division. Saul is a Division engineering representative.

VICTOR R. FARLOW has been transferred to the recently formed Chemical Department of the Gulf Oil Co. There he will assist in sales and market development for the company's expanding chemical business. Farlow joined Gulf's Petrochemical Activities Unit in 1954.

EDWARD M. POWERS has retired as vice-president of Curtiss-Wright Corp. He has been a vice-president of Curtiss-Wright since 1949, when he retired from the Air Force as Assistant Deputy Chief of Air Staff, Materiel. He has served on the National Advisory Committee for Aeronautics, the Research and Development Board of the Defense Department, and the Industry and Educational Advisory Board of the Air Force's Arnold Engineering Development Center.

DAVID A. ANDERTON has been appointed assistant managing editor (technical) by Aviation Week. His assignment includes intensive reporting on fields already featured in the magazine, such as aeronautical engineering, production, avionics, and new equipment, plus development into new features such as guided missile engineering, nuclear weapons and powerplant development, astronautics, and the new aerodynamics required by hypersonics.

During his five years on the magazine, Anderton has become particularly well known for his technical reports on new American, British, and Russian aircraft and missiles.

SAE Fathers and Sons

RICHARD N. ZEDER (right), son of 1950 SAE President JAMES C. ZEDER (left), is a brand new SAE member. He was formerly an enrolled student with the SAE Student Branch at the University of Michigan. After his graduation in February, Richard joined Chrysler Corp. as junior methods engineer. His father is a vice-president of the corporation.

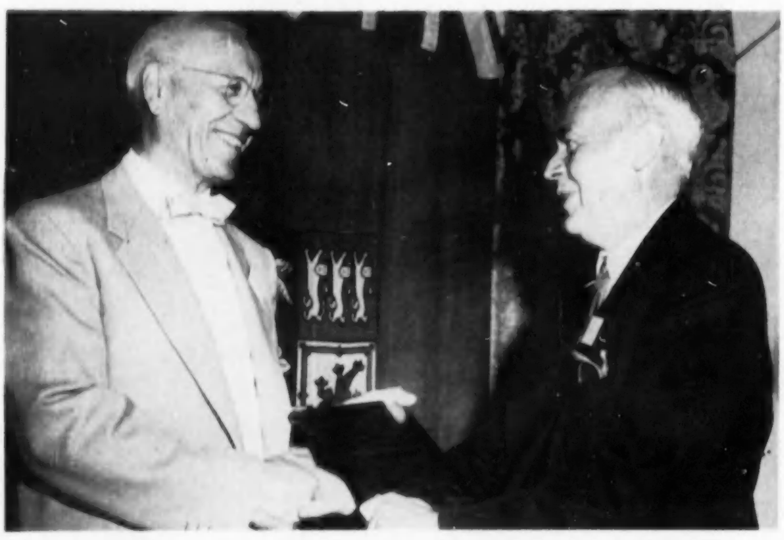
GORDON H. MAXWELL (left), national director of maintenance, Hertz Truck Lease Service, Hertz Stations, Inc., presents his son, JAMES G. MAXWELL (right). James is an enrolled student with the SAE Student Branch at General Motors Institute.

NORMAN M. JONES has become consulting engineer for the Mechanical Division, Arcole Midwest Corp., Evanston, Ill. He has been serving as chief engineer for the division. He designed and built a self-propelled subgrade planer for cutting and compacting highway subgrade in one operation.

HUDSON W. KELLOGG has been appointed manager of the Gasoline Testing division of Ethyl Corp. He replaces **J. CLIFFORD POPE**, who died recently.

Kellogg has been assistant manager of Gasoline Testing since 1946. He has been with the company since 1929.

GROVER LOENING (left), pioneer airplane designer-inventor and outstanding air consultant, receives the U. S. Air Force award for exceptional civilian service from former Secretary of the Air Force Harold Talbott. Loening has served in an informal scientific and technical advisory capacity on research and development planning, in company with Gen. Charles Lindbergh and other leading engineers and scientists, during the last two years.



W. H. HERBERT (left), vehicles superintendent, Bell Telephone Co., Montreal, Quebec, Canada, accepts a bronze plaque for the Vehicle Group for a 25-year safety record. The record was set by a group of Bell Telephone drivers, inspectors, mechanics, and clerks who did not suffer a single accident that caused loss of time on their jobs. Herbert himself has accumulated a 42-year period free of accidents of any kind.

JAMES E. YINGST is now associated with the Automotive Division Laboratory, Thompson Products Co., Cleveland. He was assistant engine engineer with Willys Motors, Inc.

JOHN B. MOORE has recently established Products and Methods Laboratories as a consulting service for industry in the field of solvents selection and application, safety and hygiene. He has published an article entitled "Securing Solvent Safety" in connection with this work. This activity is not affiliated with his participation as technical director of John B. Moore Corp., Nutley, N. J.

FREDERICK TISDALE CUSHING, formerly regional manager for Autocar Division, White Motor Co., Cleveland, is now national fleet sales supervisor with Dodge Truck Division of Chrysler Corp.

BERNARD L. RICE has been appointed sales representative for Weston Hydraulics, Ltd., subsidiary of Borg-Warner Corp. He will represent Weston in Southern California.

WILLIAM P. LEAR, founder and chairman of the board of Lear, Inc., has established residence at Geneva, Switzerland. His extended European visit is to explore product designs and manufacturing techniques abroad; develop license arrangements; and evaluate foreign manufacturing and export-import opportunities.

FREDERICK C. FOSHAG is now manager, Plant Operations Branch, Engine Test Facility Division, ARO, Inc. He is responsible for all engineering and administrative duties involved with the operation of the Arnold Engineering Development Center's Engine Test Facility, including the Ram Jet Addition.

He had been supervisor of the Engineering Section, Operations Branch, Engine Test Facility Division.

JACK DAVIS has been appointed national sales manager of the Marine Division of Bushings, Inc., Royal Oak, Mich. Products under his jurisdiction will include the Electro-Marine Generator, a hydraulic marine steering unit, and a marine refrigeration unit.

HENRY H. JONES has announced his resignation from Houdaille-Hershey Corp., where he was manager of the Detroit Office for the Buffalo Division. He was a member of the Houdaille sales department for 14 years. In his new work he will be manufacturers agent operating under the name of "Henry Jones and Associates". Operation will be in Michigan and adjacent states from 18420 Bedford Rd., Birmingham, Mich.

HARRY STOLAR has been appointed assistant general manager of the Marshall-Eclipse division of Bendix Aviation Corp. He has been factory manager in charge of manufacturing since World War II.

DON GARNER will supervise the Champion Spark Plug Co.'s automobile and marine racing engineering program, while **EARL TWINING** will continue to cover major racing events, such as Indianapolis and the Gold Cup races. Garner has been assigned solely to the racing engineering program. He will be responsible for overseeing the coverage of all racing in which Champion has an interest.

JAMES L. MYERS has retired as president of Clevite Corp. He will now devote full time to his position as chairman of the board of directors.

WILLIAM G. LAFFER, until now president of Cleveland Graphite Bronze Co., the largest operating unit in the Clevite group of companies, has been elected president of the corporation.

Myers, one of the original founders of the company in 1919, has been its president since 1948 and chairman of the board since 1952.

Laffer first joined Cleveland Graphite Bronze in 1927, starting as a tool chaser. As president of Clevite, he will have responsibility for Cleveland Graphite Bronze, Brush Electronics Co., Harris Products Co., Clevite, Ltd. (a Canadian subsidiary), and Transistor Products, Inc., as well as the Clevite Research Center and the Corporation's Central Staff.

E. C. BREKELBAUM has been elected a vice-president of Thew Shovel Co., Lorain, Ohio. He joined Thew in 1952 as director of methods.

WILLIAM R. GREEN is now associated with Jones White Truck Co. of Spokane, Wash., as truck salesman. He had served in the same position with White Motor Co. in Portland, Ore.

ROY E. MARQUARDT, president of Marquardt Aircraft Co., was the featured speaker at the August 9 meeting of the San Francisco Security Analysts. His talk, "Prelude to Power," covered his company's development of the subsonic ramjet engine, forerunner of today's supersonic ramjet—the powerplant for guided missiles and specialized high speed, high altitude aircraft.

ROGER L. DANIELS has joined Formsprag Co., Van Dyke, Mich. as project engineer. He will be concerned with engineering problems pertaining to overrunning clutches. He had been technical service manager with Timken Detroit Axle Division, Rockwell Spring & Axle Co.

GERALD F. ARNET is now associated with Chrysler Corp. as senior project engineer. His work will be connected chiefly with advanced truck design. He has been project engineer with Ford Motor Co.

JOSEPH GESCHELIN, editor, Chilton Co., has recently returned home from an extensive tour abroad. His trip included tours of Holland and Scandinavia by car and air. He also spent several days visiting Volvo plants in Gothenberg and a GMC assembly plant in Stockholm.

Obituaries

CHARLES W. KYNOCH

Charles W. Kynoch died of a heart attack on July 11. He had been well known in engineering circles in Detroit.

Born in Saint Ignace, Mich., Kynoch graduated from the University of Michigan and was a veteran of World War 1. He was connected for many years with the Export Division of the Chrysler Corp. and wrote the book "Fitting the Truck to the Job," which was one of the starting factors of the Dodge "Job-rated" trucks.

Kynock was chief engineer of the Detroit Arsenal from 1942 up to the time he retired in 1954. During this time he received a medal of commendation and certificate of Civilian Merit from the War Department for outstanding contribution to the war effort.

When he died, Kynoch was returning from a vacation to Palo Alto, Calif. where he was consulting engineer on all transportation problems for the Wetmore-Hodges Co., now Locomotive Engineering, Inc.

ROBERT J. HILGENBERG

Robert J. Hilgenberg died May 26. He had been chief tool engineer with Oneida Products Corp., Canastota, N. Y.

Hilgenberg studied industrial mechanical engineering and safety engineering at Pratt Institute and Syracuse University respectively. He was a member of the American Society of Electro Plating.

He had been associated with Oneida Products since 1950. Previously he had served with companies such as Bossert Corp., American Emblem Co., Savage Arms Corp., and Freind Mfg. Co.

CLAUDE SINTZ

Claude Sintz, president of Claude Sintz, Inc., Detroit, died July 14. He had been a member of SAE since 1917.

His apprenticeship in the engineering field was served with Gas Engine Co. and Clark Sintz Co., Springfield, Ohio. In 1893 he moved to Grand Rapids, Mich to serve as machinist with Sintz Gas Co. He took the position of engineer and secretary with Wolverine Motor Works of the same city in 1895. He then began a career of designing, engineering, and building of motors, plows, tractors, machine parts, and production parts.

He organized his own firm in the early 1900s, contracting, designing, and engineering. At the time of his death he was still serving as president of Claude Sintz, Inc., Detroit.

ARTHUR C. BOLTON

Arthur C. Bolton, fleet superintendent for Mother's Cake & Cookie Co., Oakland, Calif., died recently. He had been with the company since 1941.

Bolton started in industry as service manager with Pontiac Agency, Oakland, Calif. He then served in the same position with the Pontiac Agency in Alameda, Calif. In 1938 he opened his own business in Alameda, doing general garage works. When he joined Mother's Cake & Cookie Co. in 1941, he was master mechanic for the firm.

CHRISTOPHER BOCKIUS

Christopher Bockius, member of SAE for nearly 30 years, died June 27. He had been in retirement since 1947.

Bockius was assistant chemical engineer for Underwriters Laboratories

Continued on p. 93

Tyler and Perry . . .

. . . who won the 1954 Wright Brothers Award, will receive the 1954 Manly Memorial Medal also.

JOHN M. Tyler of Pratt and Whitney Aircraft and Edward C. Perry, Jr. of United Aircraft Corp., Hartford, Conn., will be awarded the Manly Memorial Medal for 1954 at the SAE Golden Anniversary Aeronautic Meeting, Oct. 13, in Los Angeles.

Both men also won the 1954 SAE Wright Brothers Award for the same paper on jet noise. Only twice before, in 1934 and 1944, has a paper won both medals in the same year.

The Manly Award honors "the author of the best paper relating to the theory or practice in the design or construction of, or research on, aeronautic powerplants or their parts or accessories, which shall have been presented at a meeting of the SAE."

Tyler and Perry's paper entitled "Jet Noise," which was presented at the 1954 SAE Aeronautic Meeting in New York, showed tnat the noise of jet engines may be reduced by using less-than-maximum thrust during take-off. The authors found that a larger engine is appreciably quieter than a smaller engine at the same thrust.

They also established a test procedure for predicting from scale models the noise power level of full-scale jet engines. This will be increasingly important as more work is done in solving the airport noise problem.

The paper appeared in full in the 1955 SAE Transactions and in abridged

1955 SAE GOLDEN ANNIVERSARY NATIONAL MEETINGS . . .

October 11-15
Aeronautic Meeting
Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, Calif.

October 31-November 2
Transportation Meeting
The Chase, St. Louis, Mo.

November 2-4
Diesel Engine Meeting
The Chase, St. Louis, Mo.

November 9-10
Fuels and Lubricants Meeting
The Bellevue-Stratford
Philadelphia, Pennsylvania

1956 SAE National Meetings . . .

January 9-13
Annual Meeting
The Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Michigan

March 6-8
Passenger Car, Body and Materials Meeting
Hotel Statler
Detroit, Mich.

March 19-21
National Production Meeting and Forum
Hotel Statler, Cleveland, Ohio

April 9-12
Aeronautic Meeting
Aeronautic Production Forum, and Aircraft Engineering Display
Hotel Statler, New York, N. Y.

June 3-8
Summer Meeting
Chalfonte-Haddon Hall
Atlantic City, New Jersey

August 6-8
West Coast Meeting
Mark Hopkins Hotel,
San Francisco, California

September 10-13
Tractor Meeting and Production Forum
Hotel Schroeder, Milwaukee, Wisconsin

October 2-6
Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, California

October							1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31					
November			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30			

SAE

Golden Anniversary

Transportation Meeting

Preceding the SAE Golden Anniversary Diesel Engine Meeting held Nov. 2-4 at The Chase

The Chase Hotel
St. Louis, Missouri
Oct. 31-Nov. 2, 1955

General Chairman: **M. C. Alves, Union Electric Co. of Mo.**

Cutting Maintenance Costs—**Symposium**

Uses of Four-Wheel Drive Vehicles

The Differential Gas Turbine

Instrumentation—**Symposium**

New Developments in Tires—**Symposium**

V-8 Engine Program at International Harvester

Joint Dinner—November 2

SAE Golden Anniversary Transportation and Diesel Engine Meetings

"Lamplighters"—**Dr. Kenneth McFarland, GMC**

The Chase Hotel, Starlight Roof

NOVEMBER						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

SAE

Golden Anniversary

Diesel Engine Meeting

Following the SAE Golden Anniversary Transportation Meeting held Oct. 31-Nov. 2 at The Chase

The Chase Hotel St. Louis, Missouri November 2-4, 1955

General Chairman:
L. A. Wendt, Shell Oil Co., Inc.

Engine Design Session

V-8 Diesel Power

White V-106 Diesel

Smoke Session

Automotive Continuous Filtering-Type Smokemeter

Diesel Smoke in Highway Operation

Napier "Deltic" Diesel

Fuel Research Session

Operating Diesel Ignition Delay–Hot-Motored Technique

Fuel Heat Gain and Release in Bomb Autoignition

Fuel Vaporization and Ignition Lag in Diesel Combustion

Railroad Session

Air Filtration and Diesel Engine Wear–A Progress Report

Status of Diesel Locomotives in Europe

Joint Dinner—November 2

SAE Golden Anniversary Transportation and Diesel Engine Meetings

"Lamplighters"—**Dr. Kenneth McFarland, GMC**

Starlight Roof, The Chase Hotel

form in the September, 1954 SAE Journal.

John M. Tyler is chairman of the Noise Control Committee at Pratt and Whitney Aircraft, Division of United Aircraft Corp., where he has been since 1938. He received an M.E. degree in 1927 from Cornell University and did graduate work at Techniche Hochschule, Stuttgart, Germany.

Edward C. Perry, Jr., received a B.S. degree in physics from Worcester Polytechnic Institute in 1947. Soon afterwards he joined the Research Department at United Aircraft where he has been ever since. During World War II he was awarded the Air Medal and Five Oak Leaf Clusters as an officer with the 8th Air Force.

The Manly Medal will be presented on behalf of SAE by R. R. Higginbotham, who is chairman of the Manly Memorial Board of Award, at a luncheon in Los Angeles' Hotel Statler, October 13.

You'll . . .

. . . be interested to know that

A NEW NAME HAS BEEN GIVEN TO SAN ANTONIO DIVISION. At the request of the Texas Gulf Coast Section and the San Antonio Division of the Section, the Council has approved changing the name of the Division to the "South Texas Division of the Texas Gulf Coast Section." The title of the Texas Gulf Coast Vice-Chairman representing San Antonio Division has been changed accordingly to "Vice-Chairman representing South Texas Division."

★

CERTIFICATES FOR MORE THAN 50 YEARS OF ACTIVE SAE MEMBERSHIP have been authorized by the Council. The design of the certificate will be in keeping with that of the current 25 and 35 year recognition certificates. They will be presented to the recipients by the Sections in whose territories they reside.

★

SAE WILL JOIN WITH OTHER engineering societies in co-sponsoring the ASME Air Cargo and Heavy Press programs to be held during the ASME Diamond Jubilee Annual Meeting, Nov. 13-18. The meeting will be held in the Conrad Hilton Hotel, Chicago, Ill. These programs are similar to the ones

Continued on Page 91

SAE Section Meetings . . .

Atlanta—Nov. 7

Briarcliff Hotel. Dinner 7:00 p.m. Meeting 8:15 p.m. "The New Continental"—Jesse W. Richards, Continental Division, Ford Motor Co.

Buffalo—Oct. 19

Hotel Sheraton. Dinner 7:00 p.m. Meeting 8:00 p.m. "Automation"—C. Hautau, Hautau Engineering Co., Detroit.

Central Illinois—Oct. 24

A-C Plant, Springfield. Dinner 6:30 p.m. Meeting 7:45 p.m. "An Industrial Nuclear Power Plant." Speaker from Allis-Chalmers Mfg. Co. Special feature: coffee speaker on subject of Municipal Water Systems.

Chicago—Nov. 15

Knickerbocker Hotel. Dinner 6:45 p.m. Meeting 8:00 p.m. "The Role of the Turbine in Future Vehicle Powerplants"—1955 SAE President C. G. A. Rosen, Caterpillar Tractor Co. Special feature: SAE National President's Night Social Half-Hour at 6:15 (sponsors to be announced).

Cincinnati—Oct. 24

Engineering Building. Dinner 6:30 p.m. Meeting 8:00 p.m. "Automation"—speaker from R. C. A. Plant visit.

Detroit—Oct. 17 and Oct. 18

Oct. 17—Rackham Educational Memorial Bldg. Dinner 6:30 p.m. Meeting 8:00 p.m. "The Viking Rocket Story"—Milton W. Rosen, head, Rocket Development Branch, Naval Research Laboratory, Washington, D.C. Dinner Speaker Col. Lloyd E. Arnold, special assistant for Res. Affairs, Selfridge Field—"The Reserve Program and Its Relationship to Industry."

Oct. 18—Junior Group Meeting. Tour of Ford Foundry.

Indiana—Oct. 14 and Oct. 20

Oct. 14—Fort Wayne Division. Van Orman Hotel. "Civilization Through Tools"—M. A. Bergson, Do-All Co.

Oct. 20—Marott Hotel, Indianapolis. Dinner 7:00 p.m. Meeting 8:00 p.m. "Super Alloys, Air and Vacuum Melted"—Frank M. Richmond, Universal Cyclops Corp., Bridgeville, Pa. Special feature: Social Half-Hour 6:30 p.m.

Kansas City—Oct. 24

World War II Memorial. Dinner 7:00 p.m. Meeting 8:00 p.m. "In Quest of Creativeness"—1955 SAE President C. G. A. Rosen.

Metropolitan—Oct. 20 and Nov. 3

Oct. 20—Engineering Societies Bldg. Meeting 7:45 p.m. "The New Reo Truck Engine"—R. M. Tullos, service operations manager, Reo Motors, Inc.

Nov. 3—Brass Rail Restaurant. Cocktail Hour 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m. "What is Ahead in Automotive Safety"—Ralph J. Crosby, assistant vice-president, Marsh & McLennan, Inc.

Milwaukee—Nov. 4

Milwaukee Athletic Club. "The New Packard Torsion Level Suspension"—F. R. McFarland, chief engineer, Studebaker-Packard Corp.

Mohawk-Hudson—Oct. 12

Crossroads Restaurant, Latham, N. Y. Dinner 6:30 p.m. Meeting 8:00 p.m. "Future Trends in Automotive Engineering"—L. H. Nagler, American Motors Corp.

New England—Nov. 1

M.I.T. Faculty Club.

St. Louis—Oct. 17

Gatesworth Hotel. "Complexities of Aircraft—Primarily Combat Aircraft"—Arthur Matthews, assistant project engineer, aircraft F-101, McDonnell Aircraft Corp., St. Louis, Mo. Special feature: Parks College Student Branch will make annual presentation of gavel to new chairman for the fifth year.

Southern New England—Nov. 9

Rockledge Country Club, W. Hartford, Conn. Dinner 6:45 p.m. Meeting 8:00 p.m. "Single Purpose Machine vs. Universal Type"—E. P. Bullard, III, chief product engineer, Pratt & Whitney Aircraft Division.

Texas—Oct. 14

Aircraft Meeting.

Texas Gulf Coast—Nov. 11

6:00 p.m. Plant tour through Dow Chemical Co., Freeport, Texas; 7:30 p.m. Social hour, barbeque at Dow pavilion at Lake Jackson, Texas.

Washington—Oct. 18

Washington Airport. 4:30 p.m. Field trip. Inspection of Viscount, Reception Room, Capitol Airlines Hangar #3. Dinner 6:00 p.m. "Capitol Airlines' Viscount"—speaker to be announced.

INTER OFFICE MEMORANDUM

To Every SAE Journal Reader

Subject: SAE Golden Anniversary Fuels and Lubricants Meeting

The Bellevue-Stratford, Philadelphia, Pa. Nov. 9-10, 1955

Copies to

Any Interested Nonmember

Thought I would remind you that the SAE Fuels and Lubricants Meeting is coming up soon. We will want to set aside that Wednesday and Thursday, and send in our dinner ticket applications.

The program has been announced as follows:

Wednesday, November 9

Nitrogen Oxides, Combustion and Engine Deposition
Mechanism of Engine Sludge Formation and Additives Action
The CLR Oil Test
STOP sludge AND GO clean
Road Vapor Lock Incidence
A Recent Look at Some Problems Related to Gasoline Volatility

Wednesday Evening

Dinner—Bellevue-Stratford Ballroom

Thursday, November 10

Future Gasolines for Future Engines
The Knocking Behavior of Fuels and Engines
Road Rating With a Chassis Dynamometer
Problems of Fuel Injection for Gasoline Automotive Engines
Automotive Gasoline Injection

General Chairman for the meeting will be J. G. Moxey, Jr., Sun Oil Co.

co-sponsored by SAE at the last three ASME Annual Meetings.

*

ADDITIONAL ACTIVITY COMMITTEE APPOINTMENTS for 1955 have been made recently by SAE Vice-Presidents. The following have been appointed to the respective Activity Committees:

Air Transport—
Walter L. Flynn, Jr.

Transportation and Maintenance—
F. C. Horner
J. F. Winchester
T. C. Smith
F. L. Faulkner
G. W. Laurie
E. W. Templin
J. L. S. Snead, Jr.

*

ADDITIONAL VICE-CHAIRMEN have been approved for the following Sections:

Mid-Continent Section—Vice-Chairman representing Aircraft

Northern California Section—Vice-Chairman representing Student Activities and a Regional Vice-Chairman

Northwest Section—Vice-Chairman representing Fuels and Lubricants and Vice-Chairman representing Transportation and Maintenance.

SAE To Be Saluted by Automobile Old Timers

A COMMEMORATIVE scroll, saluting the SAE on its 50th anniversary, will be awarded to SAE on Oct. 28 at the 16th anniversary dinner of Automobile Old Timers in the Waldorf-Astoria Hotel, New York City. President C. G. A. Rosen will accept the citation on behalf of the Society.

Other distinguished service citations will be awarded to SAE members L. L. Colbert, president of Chrysler Corp., Pyke Johnson, former president of the Automotive Safety Foundation, Inc., and F. C. Crawford, chairman of the board of Thompson Products, Inc.

C. F. Kettering, 1918 SAE President, will be guest of honor and principal speaker at the dinner.

Chairman of the dinner committee is P. G. Hoffman, chairman of the board of Studebaker-Packard Corp. Serving with him on the dinner committee are Alfred Reeves, advisory vice-president of the Automobile Manufacturers Association; G. A. Martin, president of

Town & Country Motors, Inc., Greenwich, Conn.; and H. A. Clark Jr., owner of the Long Island Automobile Museum, Southampton, Long Island, N. Y.

Col. W. F. Rockwell, president of Automobile Old Timers and chairman of the board, Rockwell Spring & Axle Co., has indicated that Kettering's address will be broadcast by the American Broadcasting Co., and the staff of LIFE magazine will present a nostalgic stage show based on the first Glidden tour in 1905.

SAE . . .

. . . will participate in first Nuclear Engineering and Science Congress, Cleveland, Ohio, Dec. 12-16, 1955.

SAE is cooperating with more than 25 other engineering and scientific societies in presenting the first full-scale look at atomic energy in industry, government, education, medicine, and agriculture in this country. This will take place at the Nuclear Engineering and Science Congress and Atomic Exposition to be held in Cleveland, Ohio, Dec. 12–16, 1955.

Nearly 300 papers describing the latest developments in nuclear engineering and science will be presented in technical sessions to more than 2,000 persons expected to attend. The SAE is sponsoring three papers in this first Congress on radioisotopes and tracer equipment. They are:

"Application of Radioactive Tracers to Engine Research," by A. Hundere, G. C. Lawrason, and J. P. O'Meara, Southwest Research Institute.

"Radioactivity as a Sensitive Tool for Measuring Engine Deposits," by J. G. Mingle, H. W. Sigworth, and B. A. Fries, California Research Corp.

"Electrical Contact Studies with Radioactive Tracers," by C. R. Lewis, Chrysler Corp.

These papers will be presented during technical session number 28, on Monday morning, Dec. 12. Preprints are available at cost from the American Institute of Chemical Engineers, 25 West 45th Street, New York 36, N. Y. Price: 30¢ each.

Over 140 Exhibitors

The Atomic Exposition running concurrently with the Congress in Cleveland, Dec. 10–16, will be the largest showing of nuclear equipment for use in peace-time applications of atomic energy ever shown in the United States. One hundred and forty exhibitors from the United States, Canada, Great Britain, and Switzerland have already engaged space. Registrants for the Nuclear Congress will be admitted free to the Atomic Exposition. Fee for all other attending the Exposition will be $2.00.

Registration Fee for the Nuclear Engineering and Science Congress and Atomic Exposition is $10 per person. For an advance registration blank and further information write to:

Chairman, Registration Committee
Cleveland Engineering Society
2136 East 19 St., Cleveland 15, Ohio.

The Cleveland Engineering Society is one of the hosts for the Congress.

Obituaries

Continued from Page 85

in Chicago from 1910 to 1918. He then moved to the Manhattan Rubber Mfg. Co., where he was development engineer until he took over the Detroit Branch office in 1929. He joined American Machine & Foundry Co. of Brooklyn as director of engineering in 1943. When he retired, he held the position of director of business research.

As a chemical engineer, he was a member of the American Chemical Society. He had received his A.B. in chemical engineering from Swarthmore College in 1910.

DR. GRAHAM EDGAR

Dr. Graham Edgar, consultant to Ethyl Corp., died Sept. 9 after a long illness. He had been in retirement since 1952 after twenty-eight years with Ethyl.

Dr. Edgar was graduated from the University of Kentucky in 1907 and two years later received his Ph.D. in chemistry from Yale University.

As a director of research for Ethyl Corp. at the time it was formed in 1924, he conducted studies in the synthesis and determination of the knocking properties of fuel components. This research increased petroleum refining knowledge greatly and led Dr. Edgar to his work on an octane scale for measuring the anti-knock quality of motor fuels.

He was a member of the American Chemical Society, American Petroleum Institute, Institute of Aeronautical Sciences, American Society for Testing Materials, and the Institute of Petroleum Technologists in London.

CEDRIC P. LOCKTON

Cedric P. Lockton, chief engineer, Chloride Batteries, Ltd., Swinton, Manchester, England, died February 20. He had been concerned with that company since 1924.

Lockton received the degree of M.Sc. Tech. at Manchester University-College of Technology in 1923. He was a member of the Institution of Electrical Engineers and the Institute of Materials Handling in England.

He started with Chloride Batteries, then Chloride Electrical Storage Co., as assistant to the chief engineer. By 1949 he had become chief engineer.

DRURY ADAMS

Drury Adams, division representative, Industrial, for Shell Oil Co., Honolulu, T. H., died December 1.

Adams had moved to the Hawaiian Islands in 1945 to join Shell Oil there. He had served with Shell Oil in San Francisco from 1933 to 1940.

During the war, from 1942 to 1945, he served at the U. S. Navy Yard, Mare Island, as assistant estimating and planning superintendent.

Previous to 1933 he was associated with Stone & Webster Engineering Corp., Rock Island, Wash. There he served in the purchasing and handling of construction material and equipment.

He had studied engineering at the University of Washington in Seattle.

FULLER F. BARNES

Fuller F. Barnes, member of SAE since 1925, died June 18. He had retired in 1954 as president and chairman of the board of Associated Spring Corp., Bristol, Conn.

Graduating in 1910 with a B.A. from Yale University, Barnes immediately stepped into the manufacture of springs and associated products especially for automotive trade. During his career in this field, he has since served as president, Associated Spring Corp.; general manager and treasurer, Wallace Barnes Co.; treasurer, Dunbar

Brothers Co.; president, Wallace Barnes Co., Ltd., Hamilton, Canada; director, William D. Gibson Co., Chicago; and president, Barnes-Gibson-Raymond, Detroit.

Barnes is also an associate member of the American Society of Mechanical Engineers.

FRANK MAIZEL

Frank Maizel, engineer with Bendix Aviation Corp., Teterboro, N. J., died July 5. He was 37.

Maizel graduated from the College of the City of New York in 1940 with the degree of Bachelor of Mechanical Engineering. He was also a member of the Tau Beta Pi fraternity while in school.

After graduation he joined United Aircraft Corp. as a draftsman. He then served with the Hamilton Standard Propeller Division as an engineer until he entered the Air Force in 1942. He served until 1946, gaining experience as engineering officer in charge of repair of damaged aircraft.

Upon returning to civilian life he joined Republic Aircraft Corp. as a layout draftsman. In 1949 he moved to Bendix Aviation Corp. and served as engineer with that firm until his death.

IRA GARFUNKEL

Ira Garfunkel, development test engineer in the Power Development section of the General Motors Engineering Staff, was killed in an automobile accident June 26.

He had been engaged in the development of advanced engines and their associated components since he received his M.S.M.E. degree from Cornell in 1951. He also played a major role in the development of a new compressor, now in production, for automotive air conditioning use.

He was a member of Sigma Xi, Tau Beta Pi, and Pi Tau Sigma. He had been a Student Member of SAE before joining as a Junior Member in 1951.

C. A. WELLING

C. A. Welling, manager, Dow Motor Co., Inc., Houston, Texas, died in May. He had joined SAE in 1953.

Welling had been associated with Dow Motor Co. since 1933, serving as manager. Dow Motor is a large Chevrolet dealership in Houston.

HOLDEN W. RIGHTMYER

Holden W. Rightmyer, recently retired as development engineer for Standard Products Co., Research & Development Division, died June 27. He had been with Standard Products since 1951.

Rightmyer had served with American Swiss Co., Toledo, Ohio, from 1928 to 1950. During this time he progressed through many positions from draftsman to chief engineer. He designed the automobile door locks used by Chrysler Corp. during the period of 1933 to 1936 while with American Swiss. Previous to serving with American Swiss, he was associated with Electric Autolite Co. and Willys-Overland Motors, Inc.

JOHN A. COOPER

John A. Cooper, sports editor for "The Autocar," Iliffe & Sons, Ltd., London, England, was killed in an automobile accident recently. He was 39.

He had attended Coventry Technical College, Coventry, England, receiving National and Higher National Certificates in Automobile Engineering. He was an associate member of the Institution of Mechanical Engineers.

Before joining the staff of "The Autocar," he served as car design draftsman with Alvis, Ltd.; as senior designer with Chamwood Engineering Co., Ltd.; as senior designer with Automobile Developments, Ltd.; as chief car designer for Roy Fedden, Ltd.; and as chief engineer with Cowell & Watson, Ltd.

Sections

Continued from Page 81

During planning meetings, discussion often defines quite clearly the paper the group would like to get . . . area to be covered, type of data to support conclusions, applications, pros and cons. Yet many times the real meat of this discussion (defining, outlining, and specifying the paper) is not adequately relayed to the author.

Discussion related to the development of a paper could be outlined as a specification to the author as the basis for telling him what the committee wants, it was pointed out. The committee should then follow up to help the author fulfil the specifications. It is felt that this kind of guidance would not only result in better papers, but would be appreciated by the author.

Engineers Want To Grow Professionally

Desire for their own professional development is what leads most engineers to technical society meetings, according to General Electric's J. S. Alford who talked to SAE's Membership Committee recently. So, a society must provide as many chances as possible for its members to get such development. His talk, "Stimulating Engineering Interest and Activity in Technical Society Work," informed the committee of the work being done by GE in this field.

"Know Your Society"

A special feature was the story back of "Know Your Technical Society Week" conducted at the Evendale plant. This drive for active membership in technical societies included the display of promotional posters, publicity in the plant newspaper, distribution of bulletins on honors and awards, calendars of local and national events, a letter from the president of the Evendale Engineers' Association endorsing the "week," and interviews with management about the importance of technical society participation.

An engineer recognizes the opportunities available in free exchange of ideas and experience, especially with top senior engineers. He expects to profit from activity in society work.

Give and Get

One of the primary benefits of participation in society activity is the exchange of technical information. This, of course, involves giving as well as getting information. The preparation and presentation of technical papers is a valuable means of increasing the engineer's ability to communicate his ideas. There is a definite correlation

Sections

Continued from Page 95

between an engineer's skill in written and oral communications, and his participation in technical societies.

Opportunities for making presentations are quite limited. Increasing the number and scope of committees can make it possible for more members to actively and continuously contribute to some part of the society's activities.

Atlanta Leads in Membership Growth

ATLANTA Section is the leader in Growth Index in the SAE Membership League for 1954–1955 Section year. This record helped to bring Section status to the former Atlanta Group. Lead by W. R. Ramy, Sr., Membership Chairman, Atlanta took first place as winner of the Featherweight Division crown.

Winners in the other divisions, also deserving hearty congratulations, are:

Welterweight—Texas
Sam Billingsley
Membership Chairman

Middleweight—Mid-Michigan
Gordon S. Marvin
Membership Chairman

Heavyweight—Southern California
R. E. Strasser
Membership Chairman

Mid-Michigan merits special applause for being the only last-year winner to stay at the top.

THE DEADLINE FOR SAE JOURNAL SECTION NEWS IS THE 12TH OF THE MONTH PRECEDING PUBLICATION. If the 12th falls on a weekend or holiday, material must be in on the previous workday.

For example, stories and photographs for publication in the December issue must be here at SAE headquarters in New York on November 11. (The 12th is a Saturday.) Therefore, the material should be in the mail by Monday, November 7 at the latest, from most parts of the country.

Battery of 1100 H.P. Worthington Compressors at Celanese petrochemical plant, Bishop, Texas, where CELLULUBE* 220 has given efficient service since 1952.

Celanese* CELLULUBE*s

synthetic lubricants in controlled viscosities

Celanese CELLULUBES have been developed to meet the pressing need for non-carbon-forming lubricants that are both safe and efficient.

These synthetic lubricants are phosphate esters—straight chemical compounds controlled to specification viscosities. They have excellent lubricity . . . are non-corrosive, non-reactive, non-oxidizing in air compressor service.

CELLULUBES are non-petroleum oils. They greatly reduce the formation of carbon deposits, a prime source of air compressor explosions and fires.

CELLULUBES have been job-tested for 3 years in actual compressor installations. Evaluate them in your own operation. Use coupon below to order samples and complete technical data.

Celanese Corporation of America
Chemical Division, Dept. 598-J,
180 Madison Avenue, New York 16, New York.

Celanese Corporation of America, Chemical Division, Dept. 598-J, 180 Madison Avenue, New York 16, N. Y.

Please send me sample and technical bulletin on Cellulube fire-resistant Synthetic Lubricants for air compressor service.

NAME ______________________

TITLE ______________________

COMPANY ______________________

ADDRESS ______________________

CITY ______________ ZONE ______ STATE ______

Celanese* CHEMICALS

*Reg. U.S. Pat. Off.

Continued from Page 78

as a meeting ground for equipment suppliers' engineers, operators representatives, and ERDL engineers concerned with the field test program, as well as in an advisory capacity on ERDL's winterization manual. Subcommittee XV has been invited to journey out to the testing area to observe operation of the winterized tractors and grader at first hand.

Serving on the CIMTC Subcommittee are: T. A. Haller, Allis-Chalmers; F. M. Baumgardner, U. S. Army Corps of Engineers; R. J. Bernotas, Euclid Division of GMC; E. Brookhauzen, Caterpillar; H. G. Haines, Detroit Diesel; J. H. Hyler, LeTourneau-Westinghouse; G. W. LaSalle, Hercules Motors; M. G. Mardoian, International Harvester; H. M. Reichert, Waukesha Motor; J. K. Tomko, Oliver Corp.; J. E. Weishel Heil; and H. L. Wittek, Buda.

Aero Materials Specs Reviewed by Industry

DRAFTS of 16 SAE Aeronautical Materials Specifications are currently being circulated to industry for comment and criticism by the SAE Aeronautical Materials Specifications Division.

Copies of all these specifications are available for review from the SAE Aeronautical Department, 29 West 39 Street, New York 18, N. Y.

The specifications under review are:

- AMS 3212H—Synthetic Rubber, Aromatic Fuel Resistant (55–65);
- AMS 3213G—Synthetic Rubber, Aromatic Fuel Resistant (75–85);
- AMS 3214F—Synthetic Rubber, Aromatic Fuel Resistant (35–45);
- AMS 3215G—Synthetic Rubber, Aromatic Fuel Resistant (65–75);
- AMS 4352A—Magnesium Alloy Extrusions, 5.5Zn-Zr (ZK60A);
- AMS 4908A—Titanium Alloy Sheet, 8Mn, Annealed—110,000 psi Yield;
- AMS 7263—Rings, Sealing, Synthetic Rubber, Phosphate Ester Hydraulic Fluid Resistant (85–95) (Butyl Type);
- AMS 7277—Rings, Sealing, Synthetic Rubber, Phosphate Ester Hydraulic Fluid Resistant (70–85) (Butyl Type);
- AMS —— Alloy Iron Castings, Nodular, 22.5Ni;
- AMS —— Titanium Tubing, Annealed—40,000 psi Yield;
- AMS —— Solid Film Dry Lubricant Coatings;
- AMS —— Metal, Sintered High Density Alloy, 90W-6Ni-4Cu;
- AMS —— Alloy, Corrosion and Heat Resistant, Cobalt Base, 20Cr 10Ni-15W;
- AMS —— Steel Corrosion Resistant, 18Cr-9Ni (SAE 30303F) Free Machining, High Yield Strength;
- AMS —— Alloy Wire, Corrosion and Heat Resistant, Nickel Base 25Mo-5Fe-5Cr-0.60Co-0.30V;
- AMS —— Welding Electrodes, Coated, Alloy, Corrosion and Heat Resistant Nickel Base 25Mo-5Fe-5Cr-0.60Co-0.30V.

Heavier Duty Brakes For Earthmovers

Based on paper by

R. K. SUPER

Timken-Detroit Axle Division,
Rockwell Spring and Axle Co.

THE trend in the earthmoving industry towards larger, heavier, faster equipment indicates a growing need for brakes which can handle the larger loads.

Probably the internally expanding shoe brake, with a mechanical cam which spreads the shoes, can be revised to increase its energy dissipating capacity. Usually the solution is to make a bigger brake. If it can't be made larger in diameter, then capacity can be increased by making it wider. The advantages of using tires with the smallest possible rim diameter will continue to limit brake diameter. The desire to reduce over-all width of the vehicle will limit brake width. If the space limitations prevent increasing brake size, then the use of supplementary electric or fluid brakes should be considered.

Brake capacity can be increased by using cooling fins on the brake drums or spraying cool water on the drum surfaces.

To increase the torque delivery of a brake, increase the input force to the brake mechanism by the use of a power unit. Another method is to change the brake design and increase the output-input ratio.

Performance characteristics of present cam-operated brakes are quite acceptable, and in studying an increased torque output, it would seem better to increase the power input to the brake itself rather than change the fundamental brake design.

The initial impulse is to increase the size and strength of all the component parts and retain exactly the same arrangement. This means that the power unit, adjustable lever, camshaft, cam head, and brake shoes would have to be enlarged. Space limitations and the need for using specially made parts preclude this method. A new brake design should use "standard parts" to minimize cost and service problems.

To use standard units, divide the input braking force into increments which are within the range of standard units. For example: use four brake shoes instead of two. Each pair is actuated by separate cam heads. The cam shafts extend through the brake support toward the center of the vehicle where the power unit and operating lever may be attached.

Thus, the brake may be increased in size and power by the addition of brake shoes in pairs and the actuation of these by an independent camshaft and power unit. A four-shoe brake would have two power clusters; a six-shoe brake would have three.

Tests indicate that for a 56,800-lb axle load a four-shoe brake is probably

necessary. Over 70,000 lb the four-shoe brake begins to over-reach its maximum effectiveness and a six-shoe brake is advisable.

New brake designs, particularly supplementary brakes such as electric regenerative brakes and the use of torque converter mechanisms for braking, indicate that when larger vehicles are built adequate brakes will be available.

(Paper "Heavy Duty Brakes For Earthmoving Vehicles" was presented at SAE Golden Anniversary Tractor Meeting, Milwaukee, Sept. 13, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Use Governs Choice Of Friction Materials

Based on paper by

J. F. JOHNSON

Raybestos Div., Raybestos-Manhattan, Inc.

THERE are three general classes of friction materials for oil operation. They are the resilient, the semi-metallic, and the full-sintered metallic. Each has its own field of application in automatic transmissions.

The resilient has a quailty of sponginess which gives a slower buildup in applying pressures and a built-in dampening effect that tends to eliminate chatter and give a smooth engagement. The outstanding resilients, cork and cellulose materials, char to destruction at 400 F. They have a high "apparent wear" compared to other types of materials; that is, there is a definite loss in thickness due to permanent set and true wear. Accompanying extreme permanent set there is a loss of resiliency which brings about a slight drop off in friction.

Combination cork-cellulose material

Recording Vacuum Gage Checks Fuel Pump Repair

Based on paper by

WALLACE LINVILLE

Consultant to Los Angeles County Air Pollution Control District

AS a fuel pump critic, the recording vacuum gage is invaluable. When it is attached to the suction side of a fuel pump, the instrument will record the increased vacuum attained in each stroke, as the pressure drops. When the pump linkage and inlet valve are correctly adjusted, the pump requires only about eight strokes to reach its rated vacuum. Also, the vacuum holds between strokes.

But if the inlet valve is leaking, the record shows a regression of the vacuum between strokes. Too, the pump takes more strokes to reach rated vacuum.

It pays to take a vacuum pressure record of the new pump. Then there is a standard for comparison for future checks after the pump has been reconditioned.

Appraising fuel pump condition in this manner reduces unwarranted replacements—and points out the pumps that may soon fail on the road, adding considerably to the expense of a run.

(Paper "Instrumentation for the Shop" was presented at SAE Golden Anniversary West Coast Meeting, Portland, Ore., Aug. 17, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

as applied in General Motors Hydramatic and PowerGlide, Chrysler Powerflite, and Packard Ultramatic clutches, are the most widely used. Resilients have a definite pressure and temperature ceiling but work well within their limits. They are the lowest priced of any oil-usage materials.

Woven-type resilients, basically asbestos and a binder, are not susceptible to the same temperature limits. Their primary use is for single and double wrapped bands running in oil. Although having the same general friction as other resilients, they do produce a higher apparent output.

Semi-metallics are compounded from synthetic resin and 40% or more of metallic powders in combination with asbestos and friction augments. Engagement characteristics are excellent. They are used where higher unit pressures are involved and where temperatures are apt to be of a higher magnitude than those met in transmissions using resilients. Bonding failures have happened with bonding agents having a safe limit of 450 F, which suggests that it is possible to operate with skin temperatures on the mating plates appreciably higher than 450 F.

On clutch plates or on bands in oil, operation is smooth to the highest degree. Friction coefficients of 0.065 to 0.10 rank semi-metallics below resilients, but they have much greater durability.

Semi-metallics can be fashioned easily into intricate shapes and they can be machined or grooved to suit design characteristics. When bonded to center plates and correctly grooved, excellent release is obtained. In usage they rank second, with application in Buick Dynaflow plates and bands, Ford front clutch and rear band, both Chevrolet bands, and Chrysler low band.

Full-sintered metallics are made of sintered or fused metals in combination with friction-augmenting agents. Coefficient of friction is of the magnitude of 0.055 to 0.090, or below that of other materials, but metallics will take much higher unit loading and have a high rate of heat dissipation. Engagement is not as good as obtained with the resilient or semi-metallic types. Due to better heat transfer and absence of a destructible bond, the full-sintered metallics will perform under certain conditions with no increase in wear rate where other types of material would wear at an accelerated rate. Price ranges from below the semi-metallic to slightly higher. Greatest use of these metallic friction materials is in the rear clutch of the Ford Line.

(Paper "Clutch Plate Friction Materials for Automatic Transmissions" was presented at SAE Golden Anniversary Summer Meeting, Atlantic Ctiy, N. J., June 16, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Well-Handled Shop Suggestions Pay Off

Based on report by

JAMES BRENNAN

Cincinnati Milling Machine Co.

SUGGESTIONS for product change which originate in the shop should be evaluated by a committee comprised of a responsible representative from the departments of design engineering, product engineering, tool design, production planning, inspection, and manufacturing.

Committee meetings should be scheduled and every suggestion should be

reviewed in the light of the following questions:

1. Will the product be improved?
2. Will design be affected?
3. Will tooling be affected?
4. Will manufacturing method be affected?
5. Will the production schedule be affected?
6. Will it reduce cost?

A cost analysis can be prepared from the foregoing to show whether the suggestion should be accepted. If the production schedule is affected, management should be consulted to decide if and when the change should be made.

Many suggestions have been received from shop workmen which have benefited both the workmen and the company. Worker morale is improved if the originator of the suggestion is told promptly what action has been taken. If the suggestion is turned down, the man who submitted it should be given the reason for rejection. This is part of a good suggestion system, and a really good one pays off.

(This article was based on the secretary's report of the Panel on Coordination between Engineering and Manufacturing held as part of the SAE Golden Anniversary Production Meeting and Forum, Cincinnati, March 14, 1955.)

Serving on the Coordination between Engineering and Manufacturing Panel were . . .

Panel Leader:

Albert H. Dall
Cincinnati Milling Machine Co.

Panel Secretary:

James Brennan
Cincinnati Milling Machine Co.

Panel Members:

W. C. Allen
Westinghouse Electric Co.

William Averill
Cincinnati Milling Machine Co.

R. V. Garvin
Aircraft Gas Turbine Div., General Electric Co.

Paul Jung
Trailmobile Co.

George A. Zink
Fabricast Div., General Electric Co.

Anti-Noise Campaign Is Well Under Way Now

Based on report by

HENRY JENNINGS
Technical Editor, **Fleet Owner**

INDICATIVE that guardians of the public weal mean business, at least 12 states have from one to three pieces of anti-noise legislation before their governing bodies. At the same time, industry has gone into action to improve the noise situation by practical means.

To date this is what has been accomplished:

1. An acceptable noise meter has been developed by joint industry action. This device is composed of several standard instruments and meas-

ures noise in sones. It is satisfactory in the hands of laboratory personnel. An instrument to serve as a "no" and "no go" gage in the hands of law enforcement agencies does not appear to be feasible.

2. Many members of industry have informally agreed upon a noise level of 125 sones. This level seems to be gaining the stature of an industry standard. Vehicle manufacturers seem willing to certify new model vehicles at this noise level by prototype. Virtually all new trucks meet this standard.

3. The Muffler Manufacturers Institute is working toward a similar certification for replacement mufflers.

However, it's not easy to hit on a satisfactory method of enforcing noise regulation at the user level by police authorities, except for the offender who is away out of line.

Maintenance outside of the exhaust system has very little to do with noise. A badly maintained engine or transmission makes very little more noise than a new one. Better design would help a little but it is a complex matter.

(This article is based on the secretary's report of Round Table on Smog and Noise Reduction held at SAE Golden Anniversary Summer Meeting, Atlantic City, June 15, 1955.)

Experts at the Smog and Noise Reduction Round Table Were . . .

Panel Leader:

Emil Gohn,
Atlantic Refining Co.

Panel Secretary:

Henry Jennings,
Fleet Owner, McGraw-Hill Publishing Co.

Panel Members:

Fred Hague
Sun Oil Co.

L. C. Kibbee
American Trucking Associations, Inc.

A. Moreland
Fifth Avenue Coach Co.

Robert Shertz
Subcommittee, Air Pollution Control Committee, Greater Philadelphia Chamber of Commerce.

New Device Tests Power Shovel Clutches

Based on paper by

E. A. NIX

Power Crane & Shovel Div., Dominion Engineering Works, Ltd.

A DYNAMOMETER has been designed for evaluating power crane and shovel clutch characteristics under controlled conditions. Thus far, tests have been limited to examination of clutch lining behavior and determination of torque capacity of different linings under varying temperatures, energy flow rates, and duty cycles. Ultimate objectives are to test production clutches and the effects of clutch adjustments as well as to study

variations in clutch designs and types.

The dynamometer is designed to handle any reversing shaft assembly from the company's range of machines. It consists of a 100-hp variable-speed direct current motor and gear reduction unit which drives the reversing shaft assembly. The inertia load comprises two flywheels which are driven by the reversing mechanism through a speed-increasing gear unit. Flywheels are laminated so that their inertia can be adjusted to simulate the inertia of the rotating parts of the shovel from which the reversing shaft is taken.

Output torque is measured by strain gages mounted on the shaft between the increasing unit and the reversing mechanism. Torque is recorded on a two-channel Brush oscillograph which receives the strain gage signal through silver slip rings and a suitable Brush amplifier. Clutch drum temperatures are measured by thermocouples embedded in the drums to within 1/16 in. of the surface. Their signals are transmitted by silver slip rings on the bevel gear hubs to a dc amplifier and recorded on the second channel of the oscillograph. Temperature can be read simultaneously on a Brown indicator.

Strain gages to record clutch band tensions are also mounted on the friction bands and can be connected by slip rings to the oscillograph. At the present time only two factors can be recorded simultaneously, but the need for equipment with more recording channels is already apparent and undoubtedly will be satisfied.

The clutches are applied by air and can be operated manually, or automatically under control of a two-circuit cycle timer which can be set to produce operating cycles from 0 to 60 sec for each clutch. Veeder Root counters record the number of cycles per test.

(Paper "Power Cranes and Shovels" was presented at SAE Montreal Section, March 21, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Strive for Simple, Accurate Tooling

Based on paper by

T. R. SMITH

Aero Design & Engineering Co.

IN planning the production breakdown, great care must be used in deciding upon the right kind and right amount of tooling. Simplicity should be the goal, its degree depending of course upon the quantity and type of parts to be made.

The planner must consider the many ways in which a part can be fabricated and assembled, then lean heavily on his experience to choose the one that gives economical production in the over-all aspect. It is easy to over-tool a part or assembly; it takes conscientious study of the conditions to plan a job for production that will make money yet furnish a part which will meet the engineering standards set for it. To achieve a well planned production program in accordance with management's desires requires close coordination between engineering, planning, tooling, and production heads.

Tooling accuracy requires that several vital factors be right. Loft data and engineering dimensions and data must both be extremely accurate. If these two are right, tooling problems are simplified. We do not believe in

building elaborate tools but rather in designing them to pick up all points in an assembly which must be matched or coordinated with other parts of the airplane. These points are designed to be accurate within themselves and have a rigidity adequate to maintain their accuracy during the strains imposed while the structure is being riveted and assembled. Rigidity of an assembly tool is paramount and a tool or jig should be designed to maintain rigidity and accuracy. Inadequate tools are costly and time delaying in production. Assembly tools, even for small structures, are best built from tubular steel members which are structurally efficient and economical. Since they are without sharp corners and protuberances, in most instances, they provide a safety factor as well.

(Paper "Coordination of Tool Design and Manufacturing Procedures" was presented at SAE Wichita Section, Nov. 13, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Develops Test Machine For Friction Materials

Based on paper by

H. W. SCHULTZ

Moraine Products Div., General Motors Corp.

FRICTION materials used in automatic transmissions can now be tested in a machine which can simulate almost any transmission operation desired.

Electronic instrumentation is used throughout, with the exception of time clocks, pressure gages, and the like which serve for visual information. A multichannel recording oscillograph together with sensing units, amplifiers, thermocouples and other associate equipment present a fast concise picture of the operational cycle regardless of duration. Any physical phenomenon convertible into an electric signal may be read and interpreted.

Here are some of the attributes claimed for this machine:

1. Operation at any desired temperature to 400 F may be achieved and recorded.

2. The effect of various oils relative to the operating properties of the friction element may be investigated and evaluated easily.

3. Accurate rate of oil flow over the element may be studied.

4. Certain noises occurring at a specific speed may be recorded and studied.

5. The apparent coefficient of fric-

tion, both static and dynamic, may be obtained and recorded.

6. Any desired hydraulic pressure may be applied on the clutch plate assembly and at any desired rate throughout the duration of the operating cycle. This is generally recorded with its corresponding torque curve.

7. Any number of cycles per minute may be obtained, provided they are within the operational range of the plate.

If desired this test unit can be converted instantly into a constant drive unit, locking the driven member in order to study constant slip applications under all conditions of speed and pressure, and recording the data outlined above.

(Paper "Experimental Testing of New Friction Materials for Automatic Transmissions" was presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 16, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Smog Fight Focuses On Auto Exhaust Gases

Based on paper by

W. L. FAITH

Air Pollution Foundation

VARIOUS proposals have been made to reduce smog-producing hydrocarbon emissions by modifying the operating conditions of engines. Most devices suggested for this purpose can be classified as:

1. Fuel cutoff during deceleration.
2. Intake manifold vacuum breakers.
3. Exhaust system vacuum breakers.
4. Throttle retarders.
5. Carburetion mixture improvers.

Since 60% of the hydrocarbons reaching the atmosphere from auto exhaust are evolved during deceleration, fuel control during this phase of the operating cycle can yield large dividends. At cylinder vacuums beyond 20 to 21 in. of Hg, it is difficult even to ignite the vapor mixture in the cylinder; hence a fuel cutoff may reduce unburned hydrocarbon emissions and still not affect engine operation adversely. Such a device would not prevent fuel condensed in the intake manifold and excess engine oil from entering the cylinder, but it would reduce losses by 80 to 90% during long periods of deceleration.

The deceleration problem could also

be handled by introducing air to the manifold when the vacuum becomes too high for good burning. The extra air should allow more nearly complete burning of the fuel drawn into the cylinders during deceleration, provided the cylinder temperature is not reduced too much. Probably this cooling could be prevented by preheating the air.

Manifold vacuum breakers have disadvantages. For example, malfunctioning could seriously affect accessories like windshield wipers powered by intake manifold vacuum. Besides, backfiring might occur.

When the exhaust valve opens, a surge of gas escapes into the exhaust manifold, and when the valve closes the momentum of the gas creates a partial vacuum in the manifold. This is adequate to operate a system for admitting air into the hot manifold, which, in turn, is drawn quickly in and out of the combustion chamber at or near top dead center during the overlap period when both intake and exhaust valves are open. This extra air would contribute something toward more complete fuel combustion.

Undoubtedly a great deal of the unburned fuel reaching the atmosphere during deceleration is that sucked into the cylinders under rich-mixture conditions when the manifold vacuum rises sharply just after the throttle is closed. A slower, more uniform release of the throttle should allow better burning. This effect, undoubtedly, explains the lower hydrocarbon emission from autos equipped with torque converters.

Most carburetion improvers involve heating the fuel or fuel-air mixture for more complete vaporization, or else they attempt mechanical dispersion of fuel droplets to a fine and supposedly stable aerosol. Both approaches are laudable in intent, but even if they were perfect they would not reduce markedly the hydrocarbon content of the exhaust. Uniform distribution of fuel to the various cylinders does have some effect, and this can be improved partially by design.

Another approach to the distribution problem is to substitute fuel injection for carburetion. This would allow better control of the fuel feed to individual cylinders and thus reduce hydrocarbon emissions due to overly rich mixtures in individual cylinders.

(Paper "Methods and Devices for Controlling the Hydrocarbon Content of Automobile Exhaust Gases" was presented at SAE Seminar on Fuels and Lubricants, Los Angeles, April 6, 1955. It is available from SAE Special Publications Department as part of SP-139 along with 5 other papers presented at this Seminar. Price: $1.75 to members, $3.50 to nonmembers.)

Three Techniques Aid Stress Analyst

Based on paper by

NED FULLER, JR.

and

R. H. STIMPSON

Ford Motor Co.

BRITTLE lacquer, bonded-wire resistance strain gages and, to a certain extent, photoelasticity have all simplified and complicated the experimental determination of strain. Strain gages simplify by making possible reasonably accurate measurements where the application of a mechanical device would be difficult or impossible. Complications arise from the electronic

and optical instrumentation necessary for the solution of the more involved problems by electric strain gages or photoelasticity.

It is claimed that quantitative results with an accuracy of $\pm 10\%$ are possible with the use of brittle lacquer under controlled temperature and humidity conditions, but our principal use has been to indicate regions of high stress for the purpose of evaluating the effects of design changes, or for locating strain gages.

Brittle lacquer has been valuable in establishing the effects of design changes on flywheels and on torque converter components. It is useful in the study of the effects of cooling fins in producing stress concentrations, and in determining the best location for reinforcing webs. We have used lacquer with varying degrees of success in the analysis of gear teeth. Here a coating of extreme sensitivity is essential because of the inherent stiffness of the teeth.

Brittle lacquer does have definite limitations. Surface roughness, such as may occur in a casting, can make interpretation of strain indications difficult if not impossible. Irregular contours, which promote coating build-up in certain areas, result in strain indications of indeterminate value. These must be kept in mind when using brittle lacquer.

Like the lacquer, bonded-wire strain gages have almost unlimited application. There are also problems connected with their use. Most installations are susceptible to what instrument men call "hash." This refers to interference from outside sources such as electric motors and wiring—and is also used to excuse what cannot be explained. The more complicated setups involve extensive electronic equipment, thus increasing the opportunity for trouble. One must understand thoroughly the capabilities and limitations of the equipment before launching a project, otherwise the difficulties encountered may overshadow the original problem.

Photoelasticity is probably the least used by the analyst, perhaps because only recently have procedures been simplified to enable routine checks to be made on complicated designs. Also, new materials are being developed which enable the analyst to fabricate more readily a model of a particular design.

Photoelasticity permits studies to be made on models of a particular part in advance of fabrication. With brittle lacquer and electric strain gage methods, it is almost mandatory to use actual pieces for analysis. Photoelasticity is, therefore, of greater value in the earlier design stages of a part, providing it is practical to make a model of photoelastic material. There is also the advantage that studies can be made in regions where the application of brittle lacquer or strain gages would be difficult, if not impossible. (Paper "Experimental Techniques in

Continued on Page 124

LONG
DESIGNS AND MAKES
THEM
BETTER
HEAT EXCHANGERS
RADIATORS
TORQUE CONVERTERS
CLUTCHES
ENGINEERING
B-W
PRODUCTION
LONG MANUFACTURING DIVISION
BORG-WARNER CORPORATION
12501 DEQUINDRE STREET
DETROIT 12, MICH.—WINDSOR, ONT.

the Stress Analysis of Automotive Components" was presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 14, 1955. It is available in full from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Trace Cause of Brake Lining Life Variation

Based on report by

HENRY JENNINGS

Technical Editor, **Fleet Owner**

THE amount of work done per square inch of brake lining and the rate at which the work is done is the fundamental reason for variations in brake lining life.

The wear rate of commercially used organic bonded linings increases in proportion to the increase in kinetic energy absorbed per square inch only so far. Depending on the constituents of the lining, a service condition can occur where the heat energy occurring during braking cannot be conducted or radiated away from the lining-drum contact surfaces fast enough to prevent reaching high interface temperatures. When this temperature reaches a certain high value, bond dissociation begins, resulting in a lining wear rate that may not be closely related to the wear properties of the materials in more moderate service.

Involved in the broad explanation for lining wear are such factors as:

The driver.

Weight distribution of vehicle.

Brake torque and working drum area and its distribution.

Synchronization or timing and rate of build-up of the actuating mechanism.

Maintenance and adjustment.

Character of terrain and nature of service.

An example of what can be done to improve braking is an advance control valve, recently developed for tractor-trailer combinations. It permits adjustable pre-selection of a signal which will cause advance actuation of the trailer power brakes. The signal is released to the trailer by electrical action created before appreciable effectiveness of the tractor brakes is attained. Its effect is to bring about an increase in intensity of trailer brake application and an equalization in the amount of braking done by each of the axles in order to distribute lining use and wear more evenly.

Ideally, the valve is adjusted through trial to provide the amount of advance needed to produce a slight drag from the trailer. Then, during an application, this adjusted degree of advance is maintained at the trailer until the control signal is overtaken by the rising signal developed by the pedal operated valve. Actuation above the point of advance increases in the same manner as with conventional systems. It is also possible to relieve the selected advance immediately if required by unforeseen circumstances.

(This article is based on the secretary's report of Round Table on Brakes held at SAE Golden Anniversary Summer Meeting, Atlantic City, June 16, 1955.)

At the Round Table Discussing Brakes Were . . .

Panel Leader:

J. V. Bassett
Raybestos-Manhattan, Inc.

Panel Secretary:

Henry Jennings
Fleet Owner

Panel Members:

N. R. Brownyer
Timken Axle Division, Rockwell Spring and Axle Co.

W. R. Freeman
Wagner Electric Corp.

E. E. Hupp
Bendix Products Division, Bendix Aviation Corp.

Stephen Johnson, Jr.
Bendix-Westinghouse Automotive Air Brake Co.

R. H. Moore
Conestoga Transportation Co.

W. E. Nichols
Midland Steel Products Co.

M. E. Nuttila
Cities Service Oil Co.

J. G. Oetzel
Warner Electric Brake and Clutch Co.

New Members Qualified

These applicants qualified for admission to the Society between Aug. 10, 1955 and Sept. 10, 1955. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

Jeff D. Andrews (A), Frank S. Jarrett (A).

Buffalo Section

John Henry Townley (J).

Canadian Section

Victor F. Baumunk (M), Samuel Sperling (A), Harris C. D. Veitch (A).

Central Illinois Section

Dale Francis Johnson (J).

Chicago Section

Kenneth L. Hanson (A), Richard H. Hinchcliff (M), Warren G. Kingsley (M), George V. Mercer (A), J. Dean Meyer (M), Frank W. Rasmussen (A), Marvin F. Schobert (A), Robert Supinger (J), J. William Tellson (J).

Cincinnati Section

Richard E. Weymouth (M).

Cleveland Section

Joseph F. Hutchinson (M), William S. McCormick, Jr. (J), Robert O. Webb (M).

Dayton Section

Robert R. Flinn (J).

Detroit Section

Shane H. Brady (J), John T. Buckmaster (M), Robert A. Carley (M), Andrew J. Crockett (M), D. J. Davis (M), Adolf Egli (M), Harold R. Fisher (J), Harold H. Gasser (A), Richard R. Golze (M), Charlton O. Goodykoontz (M), John D. Gowie (J), Eugene F. Hill (M), William G. James (A), Robert R. Lange (J), Richard E. Merrill (M), Donald D. Miller (M), Wayne Harold Mueller (J), Richard J. Piersol (M), Robert Helmer Pylkas (M), Richard M. Saxby (J), Paul Shiloff (J), Richard J. Stark (J), James C. Streicher (J), Victor M. Teerlinck (J), Wilfrid G. Torrance (A), Wylie J. Voorheis (M), Darwin A. Wasmer (M), Wallace R. Welch (J), Henry Whiting, Jr. (J), Gordon T. Wiggins (A).

Hawaii Section

Jack Qualen Blades (A).

Indiana Section

John D. Baker (A), Richard J. Brehm (J).

Kansas City Section

John B. Graef (M), Peter M. Sarles (J).

Metropolitan Section

A. Joseph Aldi (M), J. Clifford Crawford (M), Victor Emanuel (M), Thomas J. Gillick, Jr. (A), Richard M. Hofmann (M), William S. Mounce (M), William Henry Scott (M).

Mid-Continent Section

Jerome S. Mersenski (J), A. W. Perkins (M).

Mid-Michigan Section

Alfred Candelise (M), Burton P. Miller (M), Russell K. Welch (M).

Milwaukee Section

Jay Clark, II (A), John N. Eckroth (M), C. Richard Martin (M), L. H. Nordstrom (M), Edwin C. Vollrath (M).

Montreal Section

Herbert E. Carter (A), Bernard C. Pilon (A), John Norman Pryce (M).

New England Section

Hyman Cohen (A).

Northern California Section

John Richardson Barber (M), Elmore Kittower (J).

Oregon Section

William Daniel Copps (J).

Philadelphia Section

Charles M. Clapper (A), John V. Matejkovic (M), Robert A. Tross (M).

San Diego Section

Wesley Hodgetts (A).

Southern California Section

William F. Ballhaus (M), Wayne W. Baughn (A), Kenneth A. Lytle (M), Arthur A. Nemechek (M), Homer T. Seale (M), Joseph E. Stanley (M).

Southern New England Section

H. Mansfield Horner (M).

Texas Section

Jack Joerns (M), R. H. Williams (A).

Texas Gulf Coast Section

Edwin Cole Russell (A), George A. Seipp (M), George H. Wilshusen (J).

Twin City Section

Martin P. Kloet (M).

Washington Section

Lewis LaRon Gober (M).

Western Michigan Section

Will J. Squire (A), Lowell W. Syverson (J).

Williamsport Group

Judd H. Lindauer (A).

Outside Section Territory

Richard E. Doerfer (J), Karl E. Fenrich (M), James Ray Harvey (J), George L. McDonald (M), Wilfred G. Whitehouse (A).

Foreign

Archie L. Blackwood (M), India; Max B. Gratzl (M), Chile; Robert H. Jackson (M), India.

Applications Received

The applications for membership received between Aug. 10, 1955 and Sept. 10, 1955 are listed below.

Alberta Group

Guy B. Wilders.

Atlanta Section

Arthur L. Corcoran, Jr.

Buffalo Section

Arthur C. Bennett, Merle R. Wilson.

Canadian Section

Cecil E. Bovaird, Ernest N. Chorny, John Norsworthy Cram, William John Muller, Herbert Ray Schlichter.

Central Illinois Section

Francis B. Burkdoll, Robert Curtis Brown, Ralph W. Ferre, Robert L. Grover, Robert H. Pierce, Jr., Francis S. Robinson, Gerald K. Schuman, Bruce C. Tibbetts.

Chicago Section

John E. Bacon, Adam Keith Blackwood, Harold R. Boatman, Lawrence S. Boyer, George W. Dennis, Fredrick W. Gibbs, Lawrence H. Hodges, Edward E. Hupp, Owen C. Jackson, Bert W. McCleneghan, Frederic J. Norman, Wil-

Applications Received

continued

lard V. Putz, Raymond A. Schakel, Jr., Mervin E. Shanafelt, James H. Sheffler, Robert W. Temple, Paul R. Wiley.

Cincinnati Section

Robert J. Tulikangas.

Cleveland Section

Murray D. Braid, Charles F. Bush, C. Robert Case, Albert Wesley Cook, Robert B. Fell, W. Culver Hale, Don C. Price, Dean C. Reemsnyder, Charles W. Sanford, John Lee Wright.

Dayton Section

John L. Biedenbach, Ralph A. Bowerman, Norman L. Gebhart.

Detroit Section

Frederik Barfod, Alfred D. Bosley, Jr., Bruce Charles Brede, John A. Bryant, Ernst Bunning, Willard C. Cox, Francis P. Dean, Jr., James W. Dean, William L. Drayer, Edward C. Frank, George Gerdan, Jr., Thomas J. Guirey, Richard E. Hanslip, Richard E. Hulten, Thaddeus Kaszubowski, William G. Keil, Louis S. Leonard, Joseph N. Mazur, John Evans McDonald, George E. Merkle, Harvey E. Miller, Samuel Muhling, Francis E. Murphy, Ned F. Nickles, Louis F. Ponziani, William J. Richardson, James M. Ricketts, Walter H. Riley, George S. Scott, Thomas S. Taylor, Robert P. Thimot, George W. Walker, William Thurman Wells, Wallace E. Wright, Tao-Yuan Wu.

Hawaii Section

Kenneth Lewis Hensley.

Indiana Section

Adolph D. Corn, John Larry Hall.

Kansas City Section

James Alan Ray, William E. Wagar.

Metropolitan Section

Stanley Benerofe, Thomas F. Burke, Arnold Fink, Phil S. Hollar, Joseph A. Horvath, Torsten H. Lindbom, Eugene R. Roschilla, Lt. Col, Robert W. Samz, Elliott J. Siff.

Mid-Continent Section

W. Nelson Axe, William C. Gass.

Mid-Michigan Section

William Robert Martin, John C. Zehner.

Milwaukee Section

Earl F. Dau, Sigurd K. Rudorf.

40th YEAR NEWS

PARKER RUST PROOF COMPANY

PUBLISHED BY PARKER RUST PROOF COMPANY FOR THE METALWORKING INDUSTRY

On this, our Fortieth Anniversary, our humble and grateful thanks to those we have been privileged to serve during two World Wars, the Great Depression and now our period of greatest prosperity.

Parker Rust Proof Company,
R. W. Englehart, President

A LIST OF "FIRSTS" BY PARKER RUST PROOF

1. First commercial phosphate rust-proofing process (1915).
2. First high speed production phosphate rust-proofing process.
3. First process for spray application of phosphate coating materials.
4. First steel mill application for phosphate coating galvanized sheets.
5. First phosphate coating of ordnance items.
6. First substitute for tin in tin cans.
7. First phosphate coating process for wear resistance on machined elements.
8. First process for cold drawing seamless and welded carbon steel tubes.
9. First process for cold drawing stainless steel.
10. First process for cold extrusion of metal.
11. First process for treatment of metal to permit elimination of ground coat in porcelain enameling of metal (1955).

BIRTHDAY TWINS: NEW PRETREATMENT FOR PORCELAIN ENAMEL; BONDERITE WITH ICRA

Two new Parker products have been announced within a few months of the company's 40th Anniversary. One is a revolutionary new approach to porcelain enameling on ferrous metals, the other is a refinement in phosphate coating to produce more durable, more attractive paint finishes.

Parker Pre-Namel 410

This new Parker product, a pretreatment used to prepare ferrous metals for porcelain enameling, eliminates the need for a ground coat, makes it unnecessary to use premium alloys, permits application of finish coat directly on the metal.

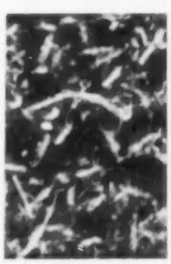
One-coat porcelain enameling over Parker Pre-Namel 410 is simpler and more economical to produce. Durability of the finish is improved, too, as shown by standard ASTM and PEI tests. Rejects and parts for re-operation are reduced to a degree never before possible. 98% acceptance has been attained in production test runs. Plant men familiar with the product estimate that economies through Parker Pre-Namel 410 will amount to from 1 to 3 cents per square foot of enameled surface.

Left: Conventional two-coat porcelain enamel on enameling iron angle failed when twisted 70°. (Metal, twisted less than its elastic limit, returned to original shape.) *Right:* Finish coat only, over Parker Pre-Namel 410 on enameling iron angle, withstood 240° twist before failure.

Parker Pre-Namel has been thoroughly tested for two years. It is ready now for use in production applications on the various types of articles finished with porcelain enamel.

New Bonderite Has Built-In Crystal Refining Agent

Series 800 Bonderites contain ICRA (Internal Crystal Refining Agent). This new built-in control produces a denser, finer, more uniform crystalline structure which results in improved paint adhesion and greater luster and reflectiveness.



Photomicrograph, 100X, of steel panel after phosphate treatment without ICRA. Note large crystals.

Photomicrograph, 100X, of steel panel after treatment with Bonderite with ICRA. Note fine, dense crystals.

This new series of Bonderites has the simplicity of operation and control, the uniformity of results and the over-all economy that characterizes all Parker products.

There's a formulation to meet almost every requirement of material to be treated, type of equipment and operating speed.

Applications Received

continued

Mohawk-Hudson Section

Leo Kaplan.

Montreal Section

Gilles Beaulieu, Gerard Daigneault, William M. Munro.

New England Section

Richard S. Weiss.

Northern California Section

Douglas John Aberle.

Northwest Section

Kenneth Francis Emerson, Richard Kenneth Fergin, W. M. Fiander, John R. Nicholas, Jr.

Oregon Section

Gordon C. Badley, Herbert S. Hutton, R. E. Peterson, Andrew D. Rintoul.

Philadelphia Section

Raymond G. Bertles, August John Dielens, Andrew D. Grey, Ford Heritage, Howard H. McCrea, Jr.

St. Louis Section

Kenneth C. Kahre, C. Richard Groninger, William D. Sims.

San Diego Section

Milburn C. Copold, Harry Croome.

Southern California Section

Harry G. Bieker, Emiel T. Bouckaert, Norbert Donald Brule, Kenneth G. Ferrel, Howard D. Houghton, Waldon T. Johnson, Leonard J. Malin, Charles G. Romary, Paul L. Sweeney, John E. Wilson.

Southern New England Section

John P. Beck, Harry Crawford Marugg, H. Clark Island, George A. Smith, Jr., Howard B. Winkler.

Syracuse Section

George E. Ellis.

Texas Section

Edward E. Ellis, Jack Philip Holman, John S. Howell, Jennings D. Means, A. A. Sinclair.

Texas Gulf Coast Section

William D. Gilder, Dwayne Lee Sparks, Henry O. Womack.

Washington Section

Donald T. Gregory, Charles W. Hess, Jr., Hubert E. Maben, Jr., Irwin L. Smietan.

Western Michigan Section

William L. Olds.

Wichita Section

Edwin D. Manspeaker.

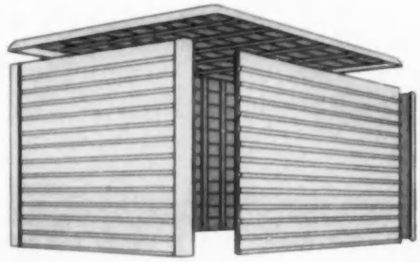
Outside of Section Territory

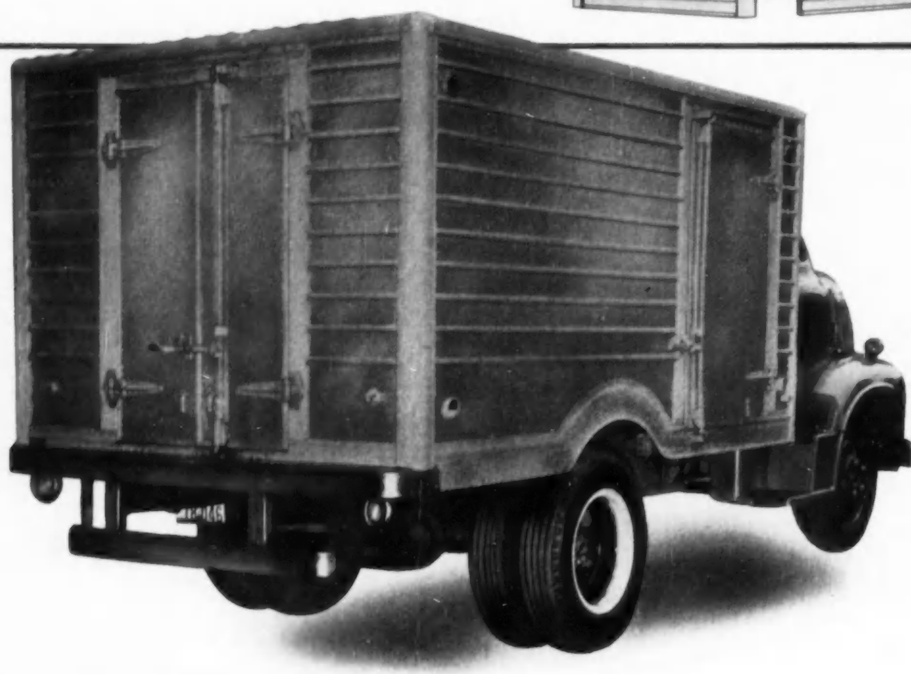
Victor H. Boettcher, Jr., William E. Coman, Richard E. Dannan, Lt. Mathew David Garred, Jr., Scott R. Harrison, George J. Stevenson.

Foreign

Donald A. Bodley, Africa; Horace C. Dean, Australia; Jose Levy, Peru; Camilo Mutis-Arango, Colombia; Jorgen Aall Myhre, Norway; Cyril G. F. Pritchett, England; Luis C. A. M. Rego, Brazil; Leonard H. Riddell, England.

Rigid, weather-tight Truck Body assembled in only *five* sections...





with **BRIDGEPORT** Aluminum Extrusions

Original design and careful planning by Andrews Industries, Inc., St. Louis, Missouri, make possible the assembly of this all-aluminum truck body in only five sections. Bridgeport worked closely with Andrews in aiding them to take full advantage of the Bridgeport aluminum extrusions which help make this design possible.

The extrusions shown are typical of the precision shapes which Bridgeport furnishes to the truck and trailer industry. Extrusions like these make possible simpler, more economical designs. In addition, they trim body weight—increase payload capacity and produce a tighter, more rigid assembly.

For the structural members of your assembly, consider the design and cost-saving advantages of aluminum extrusions. Then call Bridgeport.

Bridgeport has the capacity of a large producer plus the integrated flexibility of a small one. Our modern extrusion facilities and complete die shops produce standard or special shapes in all extrusion alloys. And Bridgeport's staff of light-metal specialists offers you prompt, individualized help in developing practical, cost-saving designs.

Call your nearest Bridgeport Sales Office for full information on aluminum extrusions, either tailor-made or standard shapes.

Precision Bridgeport extrusions like these can help improve your product and reduce production costs.

Brass Bridgeport Co.

For the very latest in

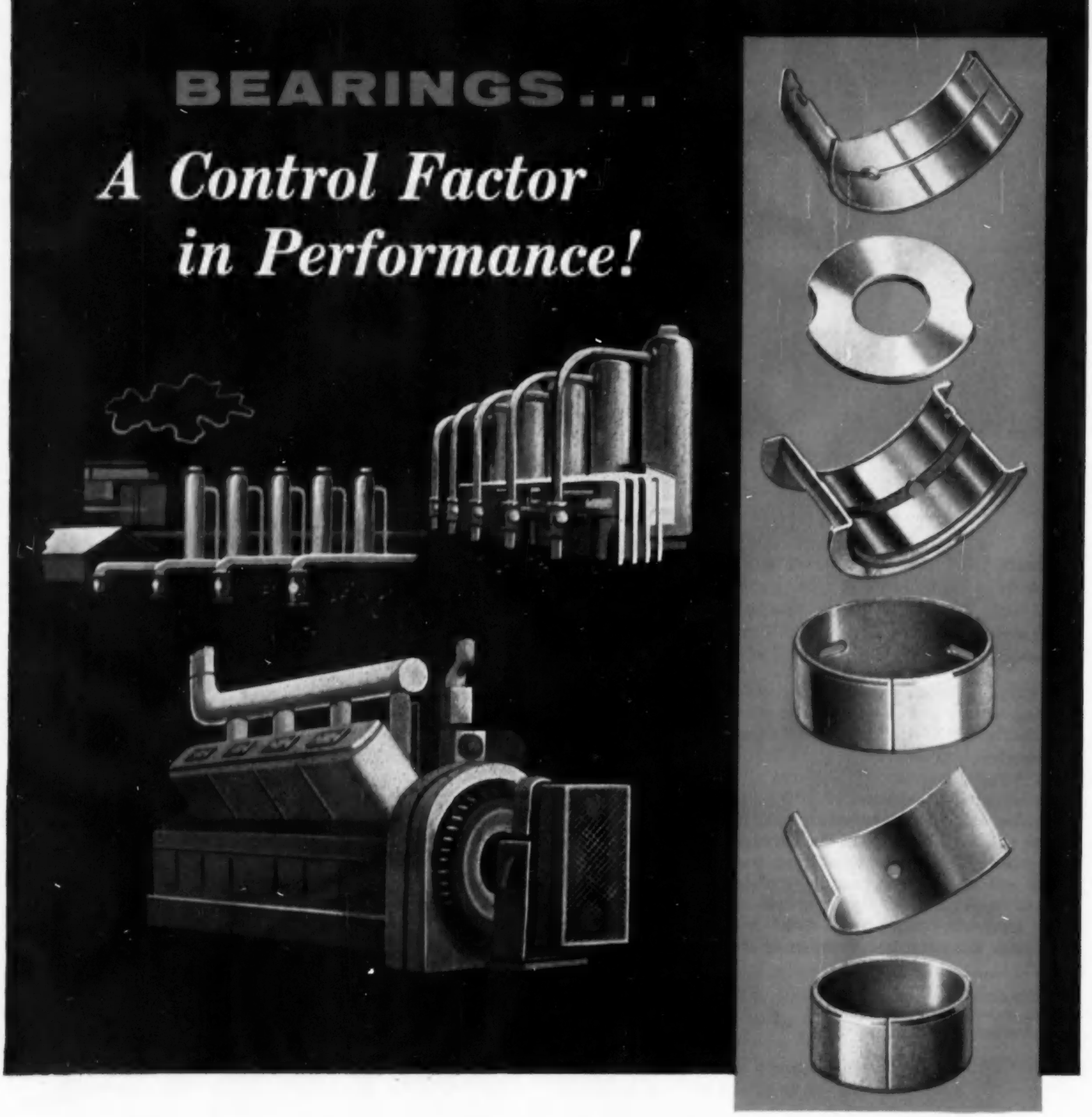
BRIDGEPORT ALUMINUM

EXTRUSIONS, DIE AND HAND FORGINGS

Bridgeport Brass Company, Aluminum Division, Bridgeport 2, Connecticut

Offices in Principal Cities


7,000
7,000 ITEMS
A KEY TO K&E LEADERSHIP
Drafting, Reproduction, Surveying, Optical Tooling Equipment and Materials
Slide Rules Measuring Tapes
● Since 1867 engineers, scientists, designers, surveyors, draftsmen have relied on K&E as the foremost, most progressive, and most complete source of supply for the tools, equipment, and materials they work with. When you buy, think first of K&E, headquarters for 7,000 items. For example . . .
ALBANENE® TRACING PAPER—This popular tracing paper is recognized as the top product in its field because of its permanent transparency, its unusual strength and its superb drawing surface.
Albanene is transparentized with an inert resin, which is permanently fixed in the fibers and unaffected by age. Its outstanding tearing strength enables it to resist wear and tear in reproduction machines and in handling and filing. Its special surface combines ideal pencil "take" with clearness, sharpness and cleanness of line.
K+E
195L
ALBANENE
PREPARED TRACING PAPER
KEUFFEL & ESSER CO.
K+E
KEUFFEL & ESSER CO.
New York • Hoboken, N. J.
Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles • Seattle • Montreal
Distributors in Principal Cities



RESEARCH · DESIGN · METALLURGY · PRECISION MANUFACTURING

One of our biggest product transportation systems is seldom seen . . . because it lies below the surface. Countless miles of pipelines carry gases and fluids to every corner of the country. Gas, gasoline and diesel engines are the muscles that power the pumping and delivery systems. Our contribution to this day-in, day-out operation is the manufacture of quality bearings for engine dependability. We are a supplier to America's builders of industrial engines. **FEDERAL-MOGUL DIVISION,** Federal-Mogul-Bower Bearings, Inc., Detroit 13, Michigan.

SINCE 1899

FEDERAL-MOGUL
DIVISION

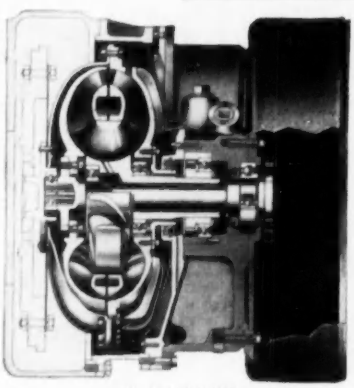
Fuller announces 3 new torque converter couplings

. . . designed for a wide variety of industrial applications

Three new Fuller Torque Converter Couplings nominally rated at 280 foot pounds of torque are now available for increasing work capacity in a wide variety of industrial applications.

The Fuller Industrial Torque Converter Couplings consist of three simple elements; impeller or pump, runner, and reaction member. With single stage two phase design, the reaction member is mounted on an overrunning clutch which permits rotation with the runner, and operation as a straight hydraulic coupling for high efficiency. The change from 2.1:1 conversion stage operation to straight hydraulic coupling stage and back is automatic, depending only upon the amount of torque required in the drive line.

Advantages of the 2.1:1 torque multiplication and smooth fluid coupling operation provided by the new Fuller Torque Converter Couplings include obtaining faster work cycles . . . with less downtime and less maintenance. Typical applications are: fork lift trucks, winches, loaders, self propelled cranes, truck cranes, lumber carriers . . . and diesel and gasoline locomotives.



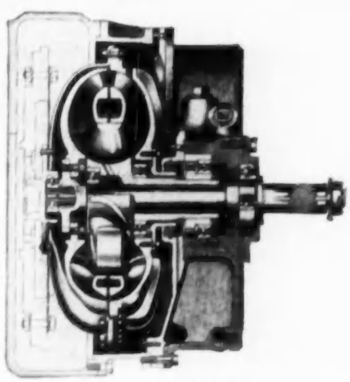
Model 12-T-280

The New 12-T-280

This new Fuller Torque Converter Coupling incorporates an SAE No. 3 clutch housing behind the converter. The output shaft is flanged for attachment of a single plate clutch flywheel.

The New 12-U-280

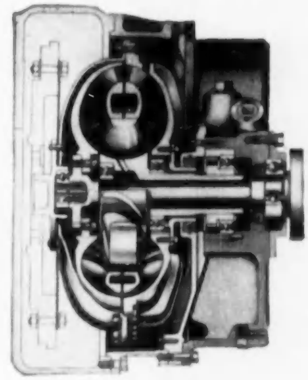
The Model 12-U-280 Fuller Torque Converter Coupling incorporates a $1\frac{1}{2}''$ ten-spline shaft on the output end, without clutch housing, for straight line drives through a universal joint.



Model 12-U-280

The New 12-H-280

A new model which incorporates a flange at the output shaft, for attachment of industrial type couplings.



Model 12-H-280

For Tough Tasks— It's Fuller by Far!

Where frequent start-and-stops, or heavy, intermittent shock loads threaten to overwork engines, transmissions, axles, brakes and tires . . . use the fluid cushioning of these new Fuller Torque Converter Couplings to *absorb* and *eliminate* shock loads.

Torque demand is matched to the load through the 2.1:1 torque multiplication of the converter . . . automatically changing to fluid coupling as the load is reduced. These new Fuller Torque Converter Couplings *keep* engines operating in the high rpm range under all conditions of vehicle load and speed.

See your equipment dealer *today*. Specify Fuller Torque Converter Couplings in your new equipment for better performance.

FULLER MANUFACTURING COMPANY
TRANSMISSION DIVISION • KALAMAZOO, MICH.

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

performance proven *by millions of installations*

- ***"No Kick-Out" feature wins overwhelming approval from car, truck and tractor manufacturers***

Although a comparatively new advancement in starter drive design, the Bendix* Folo-Thru Drive has already proven itself in millions of installations to be the most efficient starting equipment under all operating conditions.

The Folo-Thru type is specially designed to follow thru the weak explosions until the engine actually runs on its own power. Thus, quicker and more dependable starts are assured even under the most extreme weather conditions.

You're right from the start when you specify Bendix Folo-Thru Starter Drive.

ECLIPSE MACHINE DIVISION OF Bendix AVIATION CORPORATION

ELMIRA, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

Bendix folo-thru starter drive

costs less—*Like the millions of Bendix Starter Drives manufactured for the industry, the new Folo-Thru Drive requires no actuating linkage, and the less expensive solenoid may be placed in any convenient position. Result is lower installation and maintenance costs. Complete detailed information is available on request.*

*REG. U.S. PAT. OFF.

Bendix* Folo-Thru Starter Drive — Bendix* Automotive Electric Fuel Pump — Stromberg* Carburetor

TO AUTOMOTIVE CUSTOMERS

of Storm-Ravaged Eastern Suppliers

RECENT STORMS have wrought unprecedented damage to plants of many suppliers. Their normal, effective service to the automotive and aeronautic industries is temporarily crippled.

SAE JOURNAL is privileged to be a communication channel for the following messages to its more than 23,500 readers in these industries.

• *Naugatuck Chemical Division*

United States Rubber Co.

As soon as light and power facilities were restored, we were back in practically full production of basic raw materials at our Chemical and Synthetic Rubber units in Naugatuck. Freight car derailment and damaged roadbeds delayed shipping operations somewhat. This has been remedied considerably and shipments leave on schedule. Production of reclaimed rubber was resumed the latter part of September.

Naugatuck, Conn.

• *Torrington Co.*

The plants of the Torrington Co. located in Torrington, Conn., were undamaged by the recent flood in the Naugatuck Valley. The company lost about a week's production due to the loss of power, and shipments were delayed for a few days.

Torrington, Conn.

TO AUTOMOTIVE CUSTOMERS
of Storm-Ravaged Eastern Suppliers — continued

• **Wyman-Gordon Co.** Now back in production. Worcester Forging Plant had 7 to 9 ft of water from backed-up surface sewers. No damage to buildings. Comparatively little delay in shipments to customers. Forging hammers and presses back in operation Aug. 22. New England ingenuity, supplier cooperation, and hard work on the part of entire organization responsible for quick recovery.

Worcester, Mass.

• **Graton & Knight Co.** No damage thanks to comparatively high plant location and alert maintenance crew. Two-foot water level outside low northwest corner of tannery was diverted through drains which had been cleaned three weeks before flood as part of good housekeeping program. Production up to meet emergency requirements for leather belting and shipments of all industrial leather products back to normal.

Worcester, Mass.

• **American Bosch Division, American Bosch Arma Corp.** This firm was extremely fortunate in that it suffered no material damage to inventory or property. Full production of all products, electrical and diesel, continued without interruption. Delays in shipments occurred only because of surrounding conditions.

Springfield, Mass.

• **International Packings Corp.** North of the flood area, consequently no damage. Production of packings, oil seals, and molded products uninterrupted. Shipments on schedule with some being rerouted around flood areas.

Bristol, N. H.

TO AUTOMOTIVE CUSTOMERS
of Storm-Ravaged Eastern Suppliers — continued

• **Milford Rivet & Machine Co.** The company suffered no damage at any of its plants during the recent floods in Connecticut and Pennsylvania. Production continued uninterrupted at our Milford, Conn., and Hatboro, Pa., plants as well as at all of our other plants.

Milford, Conn. and Hatboro, Pa.

• **New Departure Division**
General Motors Corp. Although the city of Bristol, Conn., experienced considerable damage Aug. 19 because of flood waters, the Bristol plant of New Departure Division, General Motors Corp., did not encounter any serious interruption. Its operations in the manufacture of ball bearings, bicycle accessories, and other products resumed on a normal production schedule the following Monday. The city of Meriden, site of New Departure's other Connecticut plant, escaped the flood.

Bristol and Meriden, Conn.

• **The American Brass Co.** Severe damage occurred in many production departments at Torrington, Waterbury, and Ansonia. Cleanup and rejuvenation are progressing faster than expected. Motors need rebuilding, and machinery must be dismantled, cleaned, and reassembled. Meanwhile, copper is being diverted to Division plants at Detroit, Buffalo, and Kenosha, where 3-shift operation is coping with emergency needs of customers. In the aggregate, little production will be lost.

Torrington, Waterbury, and Ansonia, Conn.

TO AUTOMOTIVE CUSTOMERS
of Storm-Ravaged Eastern Suppliers — continued

• *U. S. Axle Co., Inc.*

About 3 ft of Schuylkill River flood water flowed into our cellar which is our carpenter shop. Electric motors were moved before water got in and damage was slight. Our plant was surrounded on three sides and there were no shipments in or out for three days. We are ready again to serve our customers in the automotive industry.

Pottstown, Pa.

• *Standard Electric Time Co.*

Although located in the midst of the flood area, Standard's plant and manufacturing facilities suffered no damage. A few suppliers were less fortunate and flood damage caused some delay in receivables from them. Production is now back to normal and deliveries of Standard Electric Timers, and other equipment are being made on schedule.

Springfield, Mass.

• *Associated Spring Corp.*

Wallace Barnes Co. Div., F. N. Manross & Sons Div., Dunbar Bros. Co. Div., Wallace Barnes Rolling Mill Div.

Most operations in the main Bristol plant were resumed on the Monday following the flood. All operations, including the rolling mill in Forestville section of Bristol, were resumed within two weeks. Three feet of flood water in both the main Bristol plant and the Forestville plant caused several hundred thousand dollars worth of damage. None of the processing equipment suffered major damage, however.

Bristol and Forestville, Conn.

TO AUTOMOTIVE CUSTOMERS
of Storm-Ravaged Eastern Suppliers — continued

• **Lapointe Machine Tool Co.** The complete production facilities of the Lapointe Machine Tool Co. are in full operation. We were fortunate not to suffer any storm damage whatsoever.

Hudson, Mass.

• **Jones & Lamson Machine Co.** Although not directly affected by either storm or flood, most of our shipping routes lie through one or the other of a damaged area. For this reason only some of our shipments may have been delayed.

Springfield, Vt.

• **Bay State Abrasive Products Co.** Operating at full capacity. Serious flood damage averted by Westboro Fire Department working with Bay State crew that kept rising water from flooding the kilns. Plant is not located in the area most seriously inundated.

Westboro, Mass.

• **Chase Brass & Copper Co.** Damage to our Waterbury mills, roughly estimated at 2½ millions, is rapidly being repaired. Remarkable progress toward recovery is being made daily. In early September, it was estimated that full-scale resumption of production would be possible in about two months, with some departments in operation earlier. Our two brass mills in Cleveland are helping to relieve the situation.

Waterbury, Conn.

aircraft
catalog

Aeroquip

REG. TRADEMARK

Hose Assemblies

Aeroquip Fittings

NOW READY!

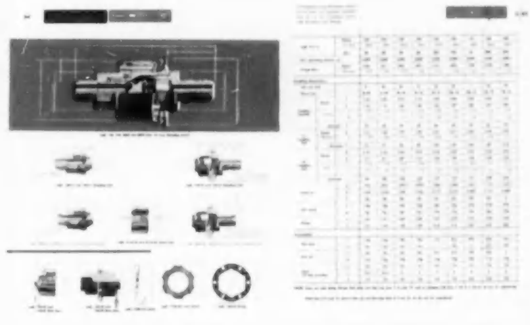
The most complete...
The most helpful...
The most informative
catalog in the field
of aircraft plumbing

SEE THE NEXT PAGE!

CATALOG No. 100

Complete Hose Line and Coupling Information

in section c

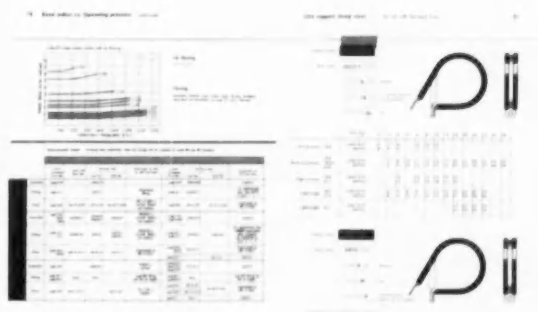


You'll find information on Aeroquip Self-Sealing Couplings for all commonly used aircraft fluids. Installation instructions are complete and well illustrated. Included are pressure loss characteristics and ordering instructions.

in section d

There is useful information on tools for hand assembly of Aeroquip hose lines, "O" ring proof-test adapters, hose cut-off machine, hose line assembly machine and accessories, and the Aeroquip Hydrauliscope.

in section e



You'll find important engineering data to help you in the selection of hose and planning installations, bend radii vs. operating pressures, conversion charts giving latest MS and MIL numbers, support clamp sizes, and more.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

AERO-COUPLING CORPORATION, BURBANK, CALIFORNIA

(A subsidiary of Aeroquip Corporation)

Local Representatives in Principal Cities in U.S.A. and Abroad. Aeroquip Products are Fully Protected by Patents in U.S.A. and Abroad.

YOU'LL FIND

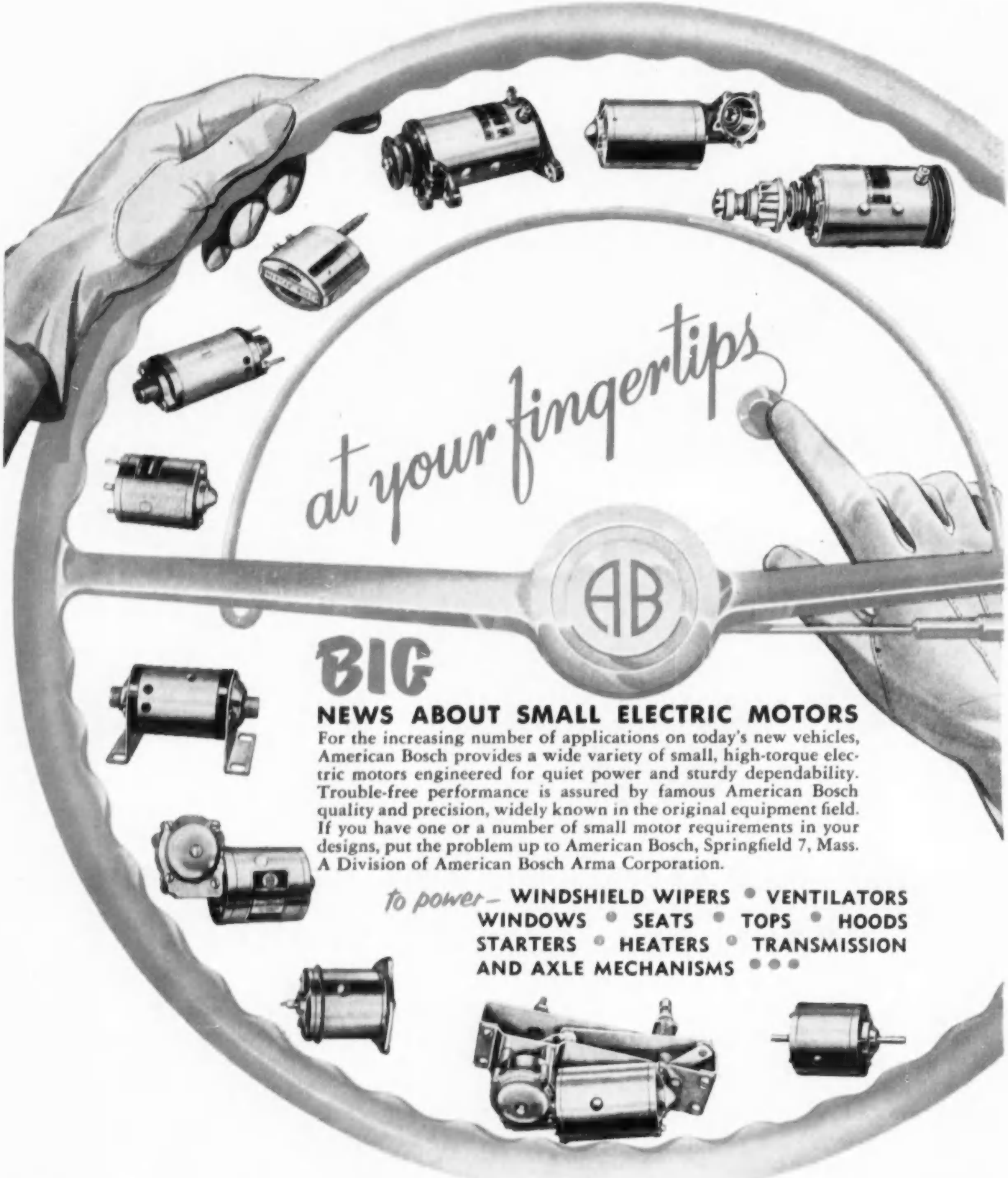
Aeroquip

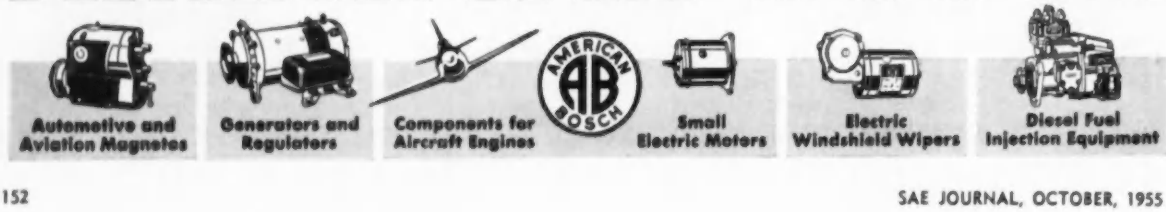
QUALITY PRODUCTS

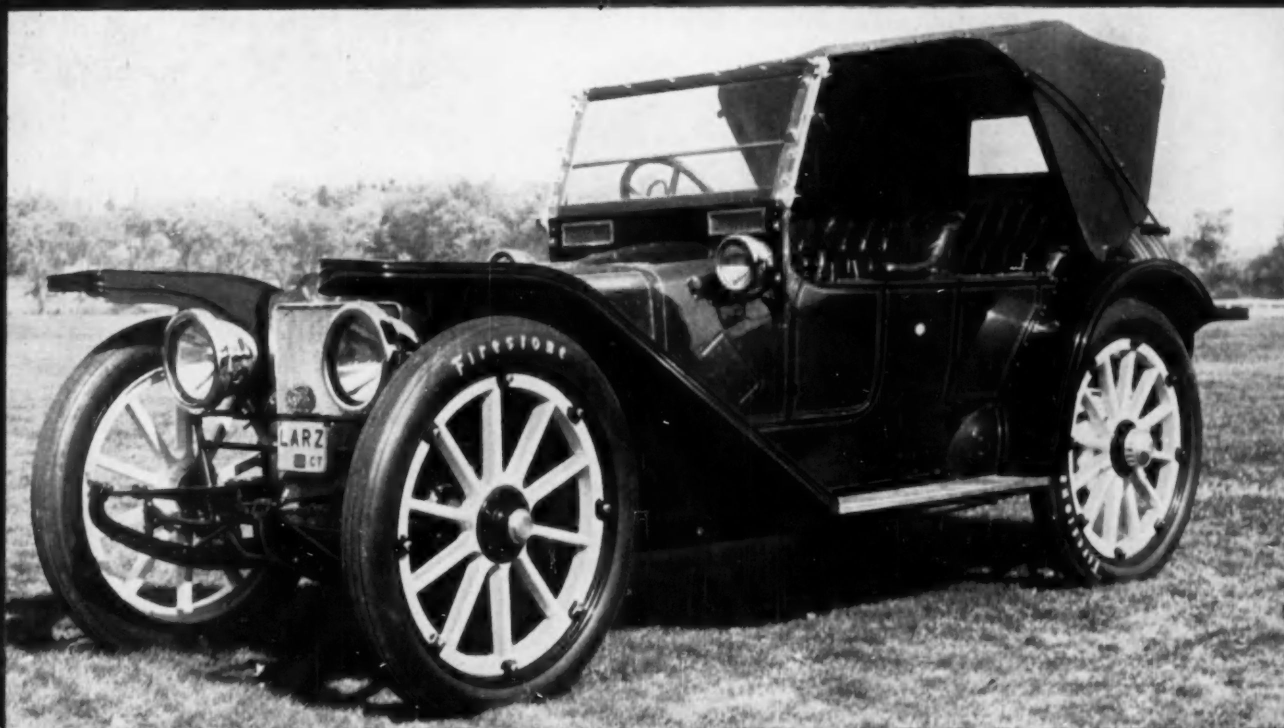
ON ALL

LEADING PLANES

AEROQUIP CORPORATION, JACKSON, MICHIGAN
AERO-COUPLING CORPORATION, BURBANK, CALIFORNIA
(A subsidiary of Aeroquip Corporation)


at your fingertips

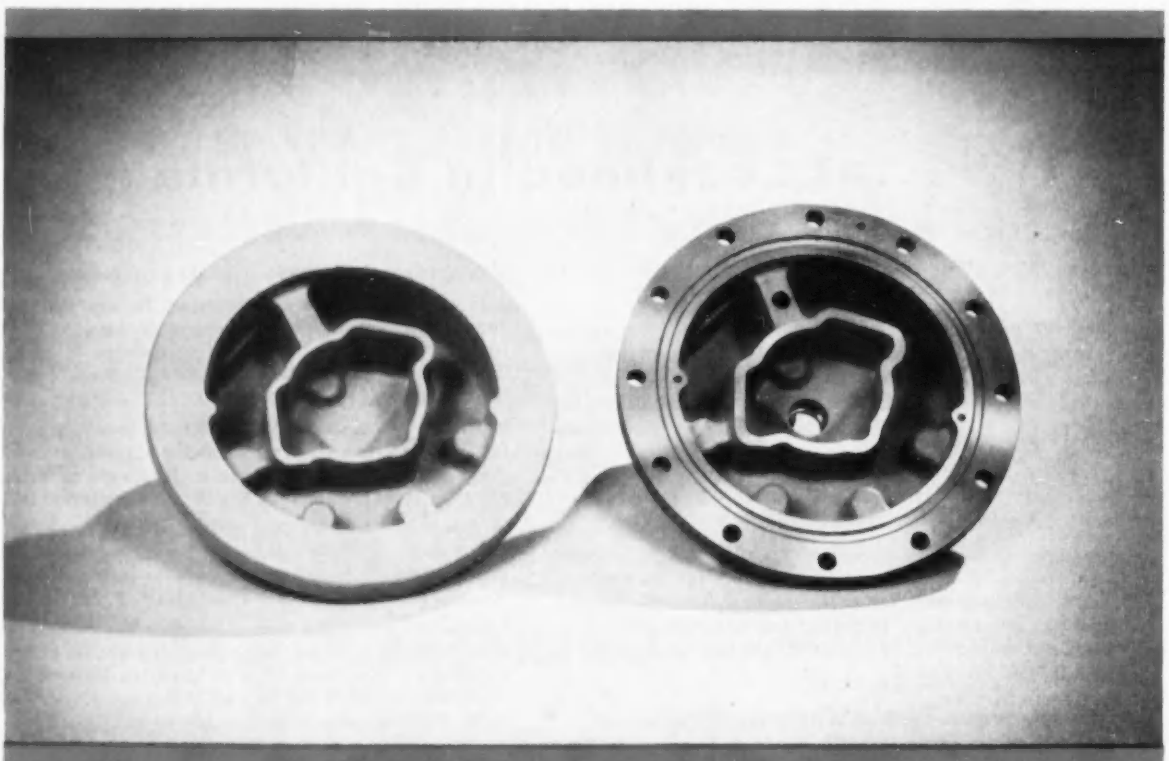

Automotive and Aviation Magnetos
Generators and Regulators
Components for Aircraft Engines
AMERICAN AB BOSCH
Small Electric Motors
Electric Windshield Wipers
Diesel Fuel Injection Equipment



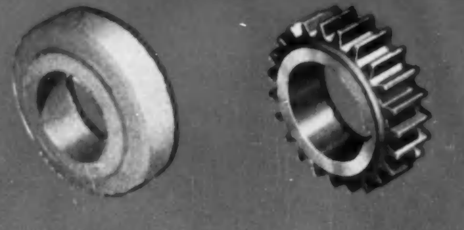
How shell castings + ArmaSteel

This compressor head casting for an air conditioning unit produced by Central Foundry Division is a good example of the improvements and savings so often realized when ArmaSteel and shell castings are combined. This part is subjected to high chamber pressures and must be free of vapor leaks. ArmaSteel has the ideal physical properties for this job including good machinability.

The shell casting process supplies clean, sand-free casting surfaces and greater dimensional uniformity which eliminates costly machining in the chamber, on the O.D. and profile milling on the contour. Thus, by using the shell casting process together with ArmaSteel in this part, material is saved, machining is saved, scrap losses are reduced 80%, and . . . due to ArmaSteel's high physical properties . . . a greatly improved product results.



= savings for you



Here are two more parts improved by shell casting. The Crankshaft Sprocket was formerly machined from bar stock on automatic screw machines. By the use of shell castings on automatic chucking machines, material and machining were saved and a product with greater performance resulted.

Rocker Arms are a typical example where the uniformity of shell castings has made the part more adaptable to automatic machining. Preliminary grinding on pad ends has been eliminated, leaving only a finish grind. Center hole is cast with a minimum of finish stock eliminating a preliminary drilling operation.

In **SHELL CASTING** the mold is formed by a thin shell of sand bonded by a thermo-setting plastic. This shell has a hard, smooth surface as accurate as the pattern itself. Shell casting has many advantages:

- **Greater uniformity**
- **Closer tolerances . . . reduced finish allowances**
- **Greater accuracy which makes intricate designs possible**
- **Improved casting surfaces**
- **Freedom from residual sand**
- **Less excess metal resulting in lower freight charges**
- **Longer tool life**

ARMASTEEL is an arrested malleable iron of pearlitic structure. The size and arrangement of carbon nodules in this pearlite result in a freely machining material that has the strength and performance characteristics usually associated with carbon steel forgings. Thus ArmaSteel offers you:

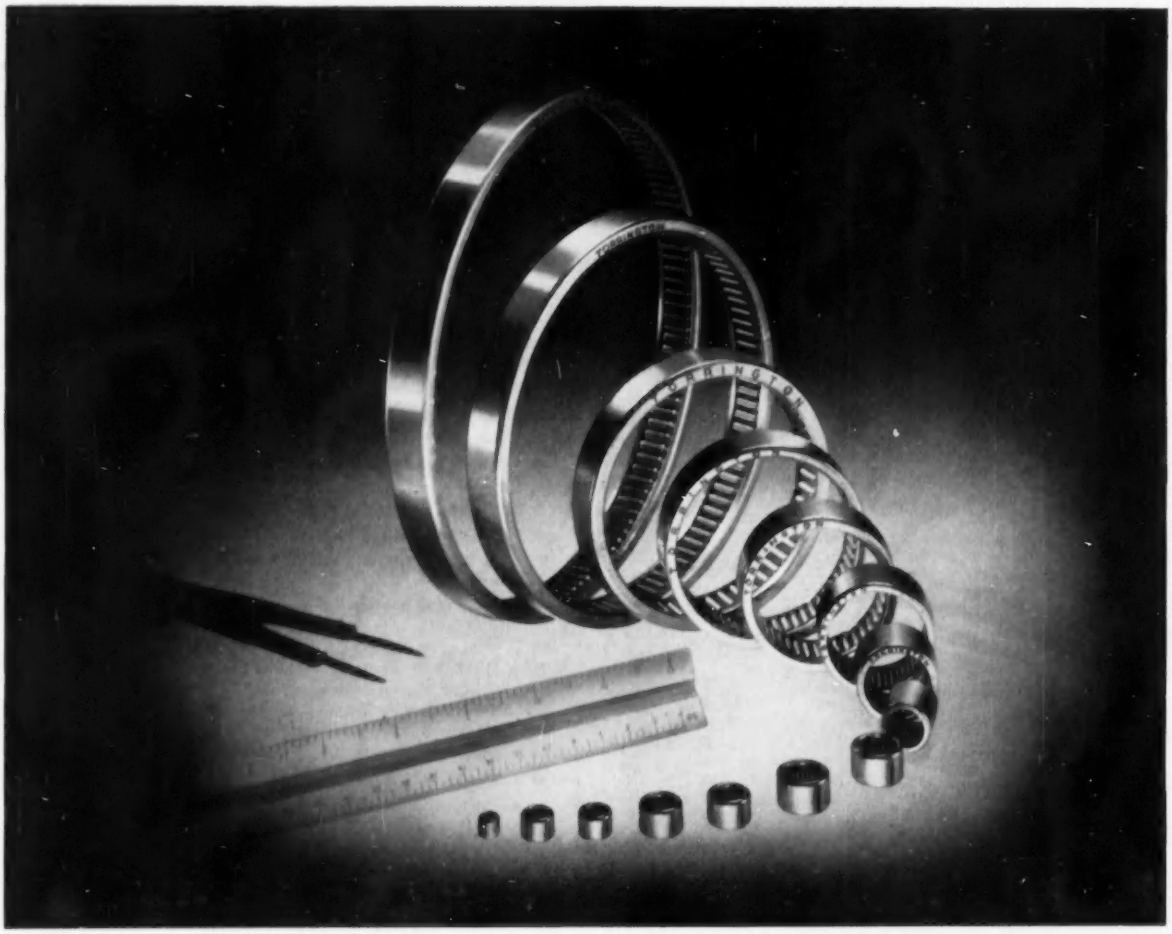
- **Uniform structure**
- **Good machinability**
- **Excellent bearing properties**
- **Good wear resistance under heavy loads at high speeds**
- **Long fatigue life, high yield strength, maximum rigidity**
- **Good damping capacity**
- **Adaptability to selective hardening**

For further information about shell or sand castings, ArmaSteel, malleable iron or grey iron castings, write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION

SAGINAW, MICHIGAN • DEPT. 18



TAILORED POWER

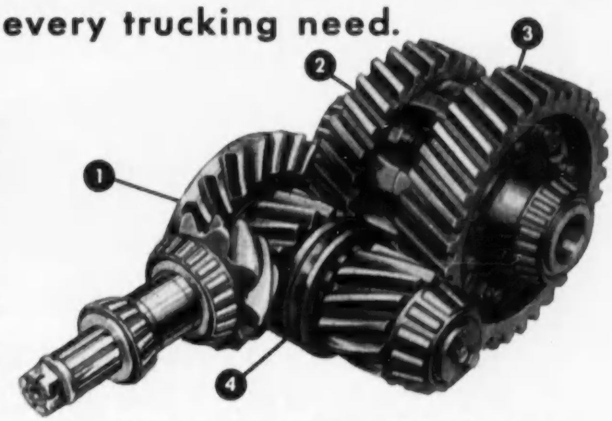
FLEXIBLE POWER is the key to profitable hauling today. A vehicle must have the *workhorse pulling power* to haul heavy loads! *Torque* is needed for bad road conditions or hill-climbing! *Speed* is needed for fast hauling, to bring an empty vehicle back for new loads sooner.

TDA 2-Speed Axles answer trucking's need for flexible power. Exclusive double-reduction design permits a range of spreads all the way from 28% to 49% . . . in an almost unlimited number of gear combinations. TDA allows tailoring the power of your truck to meet any variety of hauling conditions.

COMES TO TRUCKING

with TDA 2-speed axles

Exclusive, double-reduction design offers almost unlimited possibilities of gear ratios and ratio spreads—this versatility provides tailored power for every trucking need.



How TDA's extra "spread" works to your benefit. *All* 2-speed axles employ an extra set of gears to give two ranges of speed or power to choose from . . . one for *pulling power*, the other for fast speed. Most 2-speed axles offer only one choice of "spread"—37%. Design limitations prevent changing this standard "spread".

However, TDA uses the exclusive double-reduction design. With TDA, spreads are available all the way from 28% to 49%. This means that your axle can actually be tailored to give you just the power you need. Not only can you specify the spread most suited to your immediate trucking need — but you can easily *change* from one spread to another by merely changing the low speed helical pinion and gear — *an easy mechanical change*.

TDA's more efficient use of engine power gives important benefits . . . high road speeds, faster deliveries, better payload, and maximum fuel economy. No matter what your hauling problem or load/road conditions you save with TDA.

How TDA's 2-Speed principle works! A husky hypoid ring gear and pinion set (No. 1 above) provide the *first step* of the total gear reduction for both fast and slow ratios. Two large, heavy-duty helical gear sets provide the *second step*. Both sets are of balanced size and capacity. One set (No. 2) is for fast speed; the other (No. 3) is for slow speed. The clutch collar (No. 4) power shifts to right or left to engage one helical pinion or the other.

Greater endurance, longer truck life with TDA. TDA's simple design eliminates small complicated parts and midget size gears. Large hypoid-helical design provides more teeth in contact — quieter operation and far less strain. Bearings are larger, too. All this adds up to more profitable operation under all conditions.

TIMKEN Detroit AXLES

TIMKEN DETROIT AXLE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

DETROIT 32, MICHIGAN

The Accepted TDA Standard

TRADE MARK REGISTERED

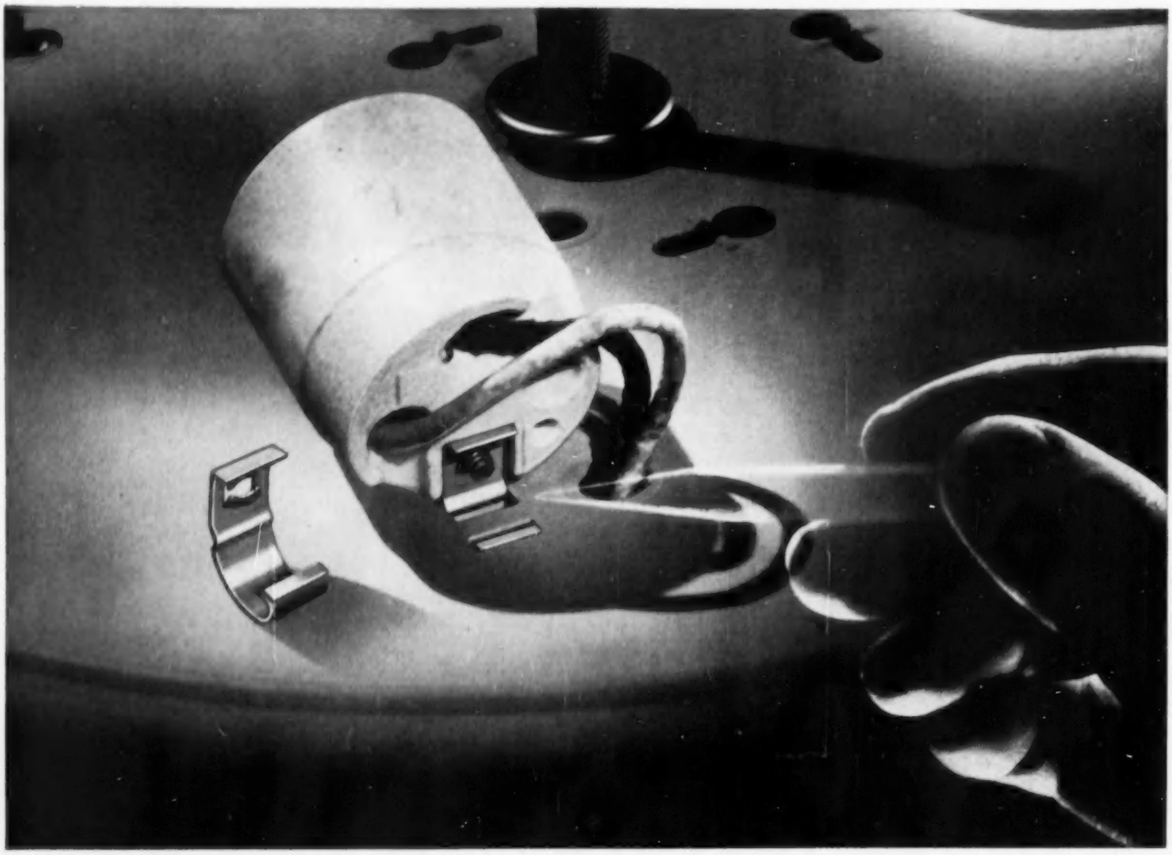
World's Largest Manufacturers of Axles for Trucks, Buses and Trailers

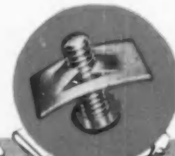
Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio New Castle, Pennsylvania

Increase axle life with
GENUINE TDA EQUIPMENT PARTS

Take no chances with ordinary replacement parts. For sure, dependable, factory-type jobs, specify genuine Timken-Detroit Axle parts kits—identical to your axles' original equipment.

Each kit is complete—gives you everything you need in one handy package. Gaskets and shims, brake liners and rivets, steering knuckles, king pins and bushings, differential nests—for every size of brake and axle. Order by number from your dealer. Cut labor and adjustment costs. Get trucks back on the road quicker.



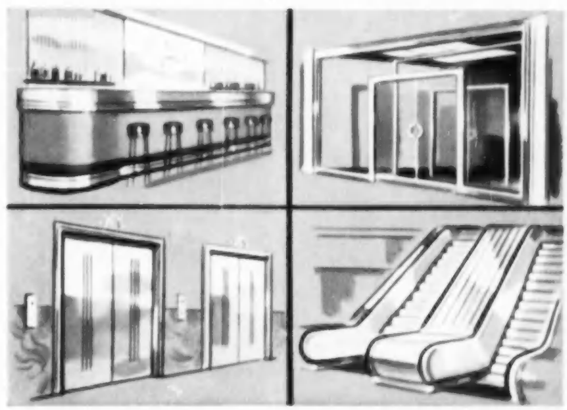


modern design specifies stainless steel

The new 42-story Socony Mobil Building, world's largest metal-clad building now under construction in New York City, will have a "skin" of 7,000 stainless steel panels. The architects and builders specified stainless for its enduring beauty, resistance to corrosion and ease of maintenance.

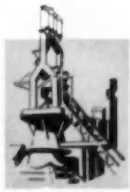
McLouth
STAINLESS
Steel

for buildings



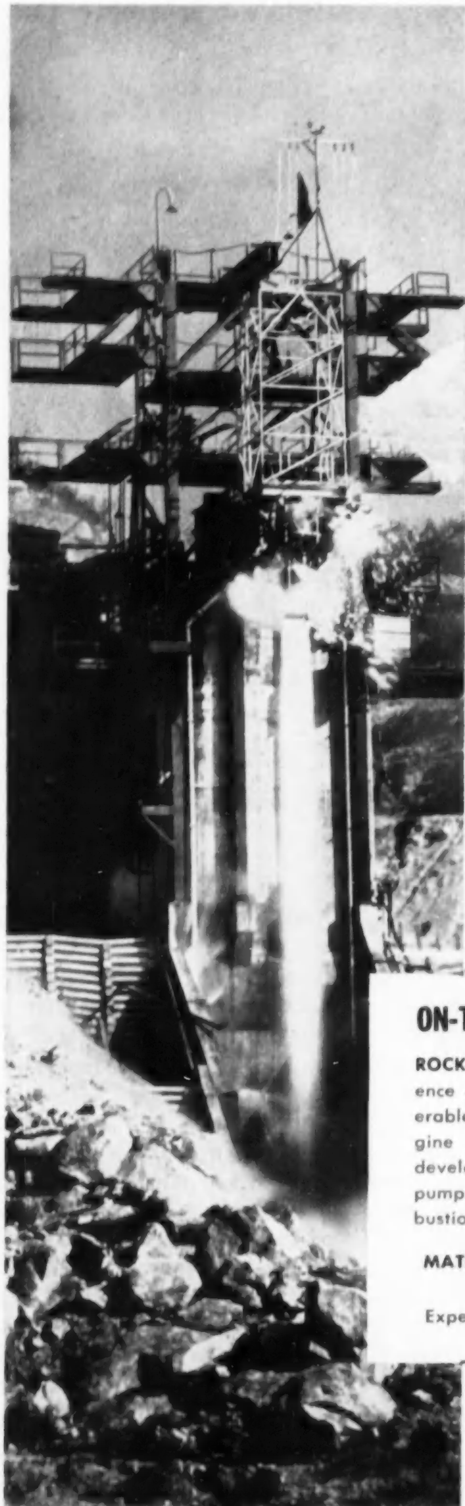
In fixtures, trim, curtain walls and hundreds of other applications you will profit by using McLouth Stainless Steel.

For the product you make today and the product you plan for tomorrow specify McLouth high quality sheet and strip Stainless Steel.



McLOUTH STEEL CORPORATION
Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS



OLIVER Super 55 Tractor uses VICKERS HYDRAULICS to provide *Super Versatility*

The new Oliver Super 55 Tractor demonstrates to excellent advantage the many benefits that Vickers Hydraulics offer the design engineer. On the Super 55, a Vickers valve and pump are used to provide the 3-point hitch tools with either automatic constant draft or automatic constant depth . . . at the flip of a lever. By addition of the Vickers 3-in-1 Valve shown below a separate and independent control system can be provided for operating front- or side-mounted equipment. Built-in overload relief protects against damage, while merely turning a knob on this valve changes the amount of oil flow for fast or slow operation.

The versatility of Vickers Hydraulics is very useful to design engineers concerned with a wide variety of other products. For information upon applications similar to your own particular needs, get in touch with the nearest Vickers Application Engineering Office listed below.

AUTOMATIC CONSTANT DRAFT CONTROL | **AUTOMATIC IMPLEMENT POSITION CONTROL**

When irregular ground or soil conditions tend to increase or decrease draft, the Vickers Servo Valve acts automatically to raise or lower the implement slightly. Movement is so smooth as to be almost imperceptible . . . with no sign of jump. Overloading, wheel slippage and stalling of tractor are prevented. Flipping a lever on the valve automatically provides constant depth regardless of ground contour or changing soil.

INDEPENDENT HYDRAULIC CYLINDER CONTROL

Addition of Vickers 3-in-1 Valve permits operation of pull-type and mounted equipment of all kinds independent of the main hydraulic system but using same pump.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
1440 OAKMAN BLVD. • DETROIT 32, MICHIGAN

Application Engineering Offices: • ATLANTA • CHICAGO • CINCINNATI CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N. J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA • WASHINGTON WORCESTER

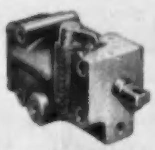
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

People who look for quality in tractors and farm equipment also look for VICKERS.

7245

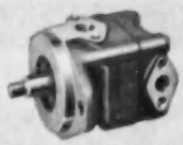
VICKERS. SERVO VALVE

Provides smooth, accurate and instant response to load or position changes of hitch tools. It is mounted inside the oil reservoir and has an external lever.



VICKERS. 3-IN-1 VALVE

Four-way directional valve with built-in flow control and relief valve is mounted externally to provide control for separate hydraulic system (front- or side-mounted equipment).



VICKERS. PUMP

Hydraulically balanced and having automatic wear compensation, this pump delivers more oil while taking less power. A single pump supplies all needs.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921


MARVEL-SCHEBLER
has a world of engineering "Know-how"
Gasoline Carburetors
especially engineered for Tractor, Aircraft and Industrial Engines
Updraft, horizontal and downdraft carburetors for tractors and industrial engines are available with fixed or adjustable power systems in sizes ⅝", ⅞", 1" and 1¼" for engines up to 100 Horsepower.
Our customers' demands—representing a wide variety of different industries—have given Marvel-Schebler the "KNOW-HOW" to solve your carbureter problems.
Whatever your particular needs, the finest engineering and production skills, with complete research and design facilities guarantee you full satisfaction when you call on Marvel-Schebler.
MA
MARVEL SCHEBLER AIRCRAFT
Aircraft float type updraft carburetors furnished in sizes 1¼", 1½" and 2" for engines from 50 to 250 Horsepower. Features: Cast Aluminum construction, Manual or Automatic Mixture Control, Idle cutoff, Dual floats for angular operation.
• Power Brakes For Passenger Cars and Trucks
• LPG Carburetion Systems For Trucks, Tractors and Industrial Engines
A line of downdraft, updraft and horizontal carburetors for industrial applications in sizes ½", ⅝" and 1" with fixed or adjustable power systems. Horsepower range 1 to 50, used on lawnmowers, outboards, generators, diesel starting engines and other special applications.
MARVEL-SCHEBLER Products Division
BORG-WARNER CORPORATION · DECATUR, ILLINOIS
BW
For a completely equipped and expertly staffed research laboratory for power brake, LPG and gasoline carburetor development . . . plus trained engineering fieldmen to assist you . . . call Marvel-Schebler!

"Wagner Air Brakes increase the service life of brake lining"

Says: R. H. WATKINS, Fleet Superintendent
TARBET TRUCKING, Inc., Muncie, Ind.

Every day WAGNER AIR BRAKES are helping more and more fleet operators establish finer records of safety and maintenance economy. These are some of the tangible advantages you can offer your customers by standardizing on WAGNER AIR BRAKES.

Much of the superiority of WAGNER AIR BRAKES is largely due to the engineering excellence that is built into every component part. WAGNER ROTARY AIR COMPRESSORS—standard on all WAGNER AIR BRAKE SYSTEMS—feature rotary motion, uniform torque load, oil separation and air cooling before discharge, high volumetric efficiency and easy, infrequent preventive maintenance. WAGNER BRAKE APPLICATION VALVES provide smooth, easy stopping. WAGNER RELAY EMERGENCY VALVES assure maximum trailer breakaway protection and eliminate the necessity of moving large volumes of air through long air lines.

All this is the result of more than thirty years of knowledge gained by WAGNER from the manufacture of brakes and complete brake systems.

Because of the ever-increasing demand for greater road and cargo safety and maintenance economy, it will pay you to include WAGNER AIR BRAKES as standard equipment on the vehicles you manufacture.

Send for your free copy of Wagner Bulletin KU-201 for full information and complete details. It will be sent to you without cost or obligation. Mail your request, today.

TARBET TRUCKING, INC.
311 EAST 10TH STREET
MUNCIE, INDIANA

GENERAL OFFICE
MUNCIE, INDIANA

ADDRESS ALL CORRESPONDENCE TO:

Wagner Electric Corporation
6400 Plymouth Avenue
Saint Louis 14, Missouri

Gentlemen:

In 1953, our company was awarded the National Fleet Safety Award for the 2 to 3 million mile class. This award is indicative of the way we operate our fleet and the high performance standards we require of the equipment and material we use.

I can definitely tell you that Wagner Air Brakes help us maintain our safety record. Their superior quality and operating dependability are features of Wagner Air that I like. They are quiet and the compressors last 2 to 2½ times longer with normal preventive maintenance. Also, Wagner Air Brakes increase the service life of brake lining 3 times.

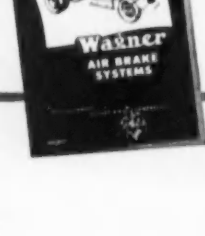
We plan to continue our policy of specifying Wagner Air Brakes when ordering new equipment and will keep recommending your air brakes to other fleet operators.

Sincerely yours,

R. H. Watkins
Fleet Superintendent

WAGNER AIR BRAKE USERS

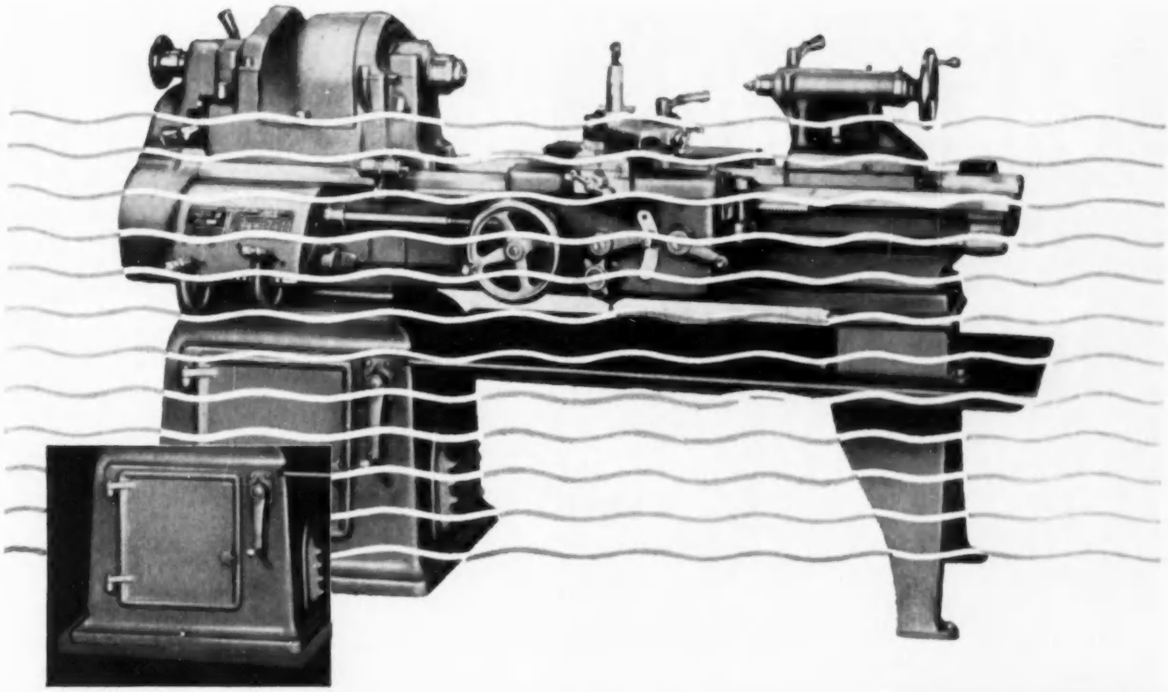
ARE OUR BIGGEST BOOSTERS



K55-11B

Wagner Electric Corporation
6378 PLYMOUTH AVENUE • ST. LOUIS 14, MO., U. S. A.
(Branches in Principal Cities in U. S. and in Canada)

LOCKHEED HYDRAULIC BRAKE PARTS and FLUID . . . NoRoL . . . CoMaX BRAKE LINING . . . AIR BRAKES . . . TACHOGRAPHS . . . ELECTRIC MOTORS . . . TRANSFORMERS . . . INDUSTRIAL BRAKES



...*First* U.S. TURBOPROP PROPELLER *to be Certificated* FOR AIRLINE USE

The first Civil Aeronautics Administration certification for commercial use of a U.S. designed and built turboprop propeller has been awarded to Model CT634S of the Curtiss-Wright Turbolectric series.

The CT634S and other Turbolectric models are already in quantity production for some of the nation's most advanced military aircraft types – both operational and experimental. The new CAA certification now makes available to commercial airlines the high standard of performance and the flight demonstrated efficiencies of Turbolectrics.

Propellers provide the most efficient means of converting gas turbine power into useful thrust. Curtiss-Wright Turbolectrics—with one-piece extruded hollow steel or solid dural blades – feature full synchronization plus synchrophasing . . . full feathering, by either manual or automatic means . . . fast reversing . . . single-lever power control.

TURBOLECTRICS ARE SPECIFIED FOR THE MAJOR U.S. TURBOPROP ENGINES, WHICH INCLUDE THE T-49, T-56, T-34, T-40 and T-38

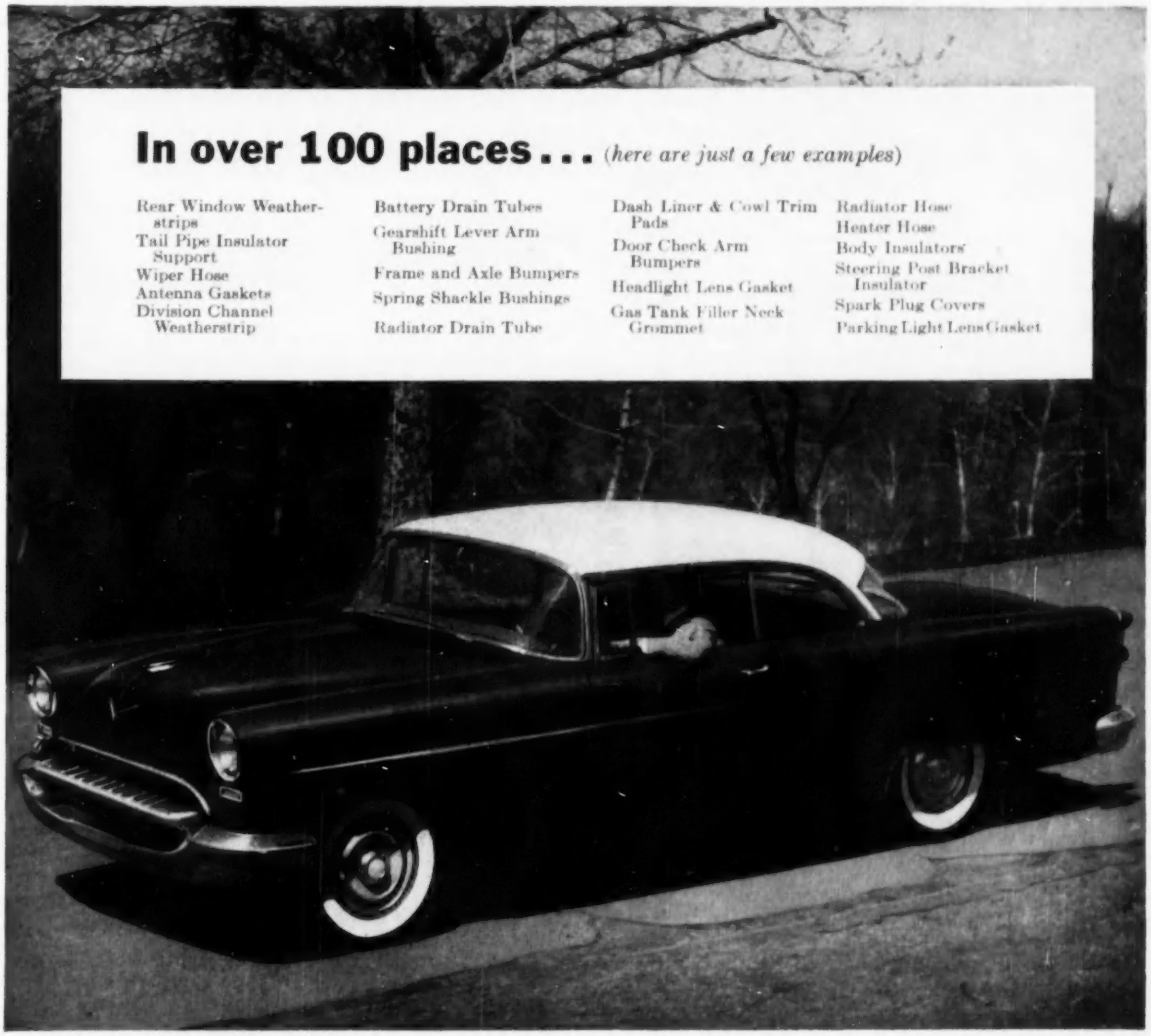
ENGINEERS • TECHNICIANS • SCIENTISTS

Curtiss-Wright has permanent career positions open for specialists in advanced engines and propellers, metallurgy, electronics, nucleonics, ultrasonics, plastics and chemistry. New 85 square mile Research and Development Center at Quehanna, Pennsylvania and expanded divisional engineering programs are creating opportunities for more engineers, technicians and scientists in both aviation and diversified industrial projects.

PROPELLER DIVISION
CURTISS-WRIGHT
CORPORATION • CALDWELL, N. J.

YOUNG MEN! JOIN THE U.S. AIR FORCE

Investigate Career Opportunities at Your Nearest Recruiting Office



Enjay Butyl parts help new cars perform better

Many of today's cars run like new, drive like new, perform like new for *extra* thousands of miles with over 100 parts made from Enjay Butyl—the super-durable rubber that has a low cost, yet outperforms and outlasts, *by great margins,* rubbers formerly used. Under the toughest conditions of weather and use, Enjay Butyl parts *stay like new.*

This amazing rubber—finding wider and wider use in the automotive industry—is now readily available in *new* non-staining grades for white and light-colored parts. For further information, and for technical assistance in the uses of Enjay Butyl, contact the Enjay Company.

ENJAY BUTYL

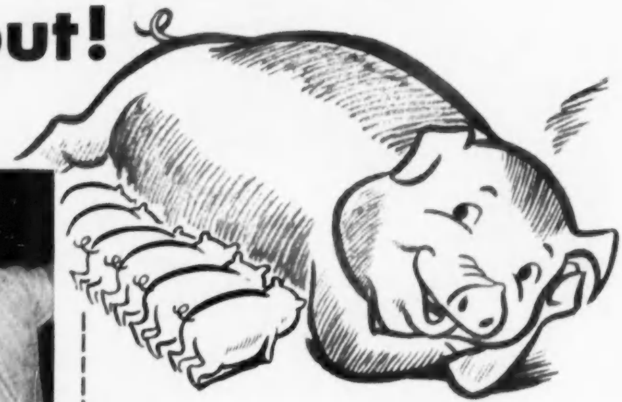
Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
District Office: 11 South Portage Path, Akron 3, Ohio.

35 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

Multiple Spindles provide Greater Output!



2-Spindle Multiples tighten connecting rod bolts on the assembly line.

A 6-spindle Multiple Nut Setter assembles automobile crankshaft to flywheel.

The new Keller Multiple Nut Setters improve quality control and reduce production costs. Manufacturers have been quick to make use of their advantages:

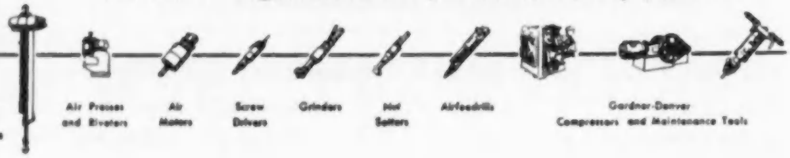
1. Built-in torque regulation in each individual spindle, giving control of torque on each bolt. Torque is adjustable from 4 to 190 ft/lb.
2. Torque held within close tolerances—comparable to that obtainable with accurate hand tools.
3. Increased production and lower production costs.
4. Easily adaptable to changing needs . . . a change in bolt spacing merely requires a new mounting plate for the spindles . . . when a job is completed the spindles are completely salvageable for use in another Multiple.

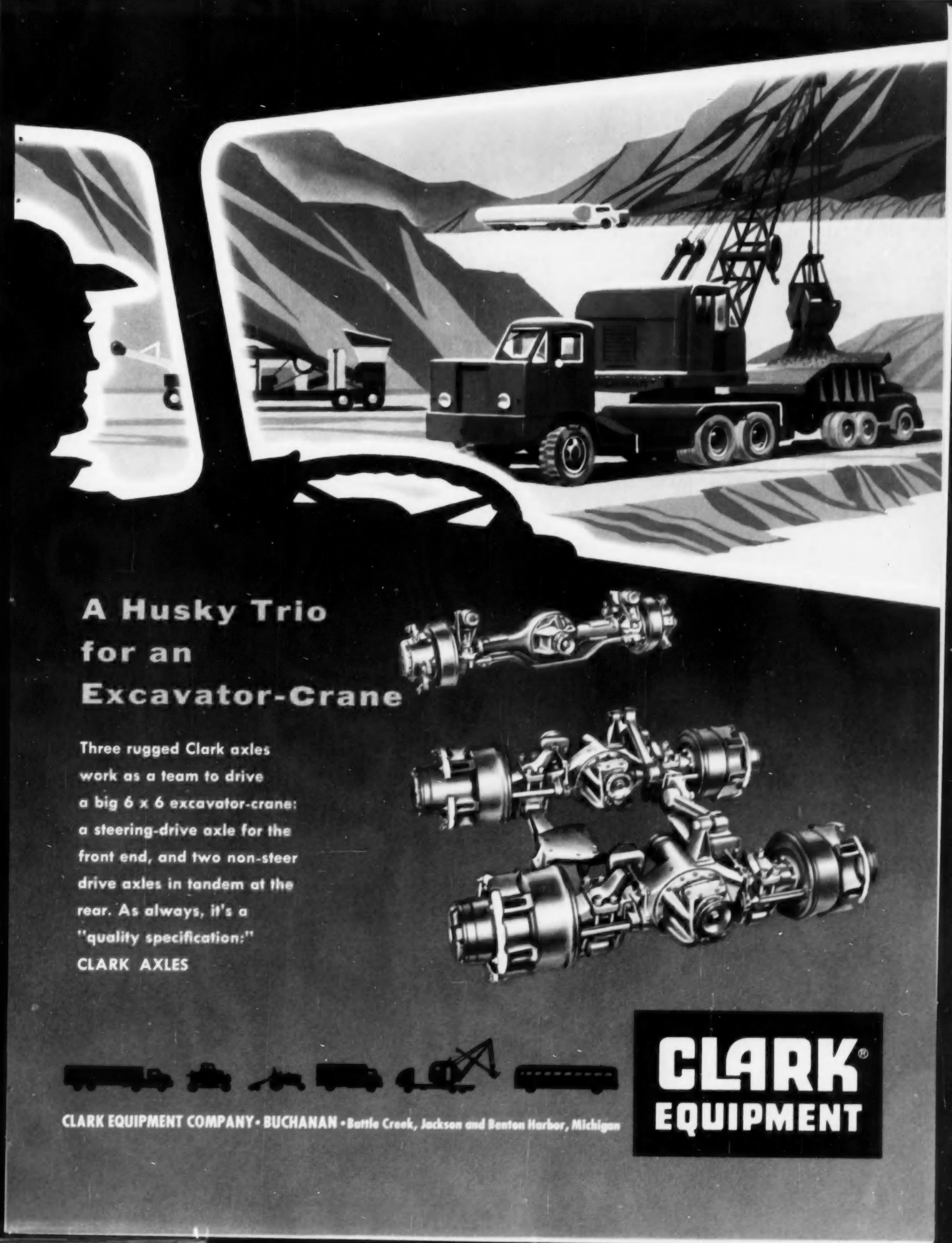
Do you have applications where bolts or nuts can be run and tightened two or more at a time? If so, it will pay you to investigate this remarkable tool. Write for Bulletin 16-101.

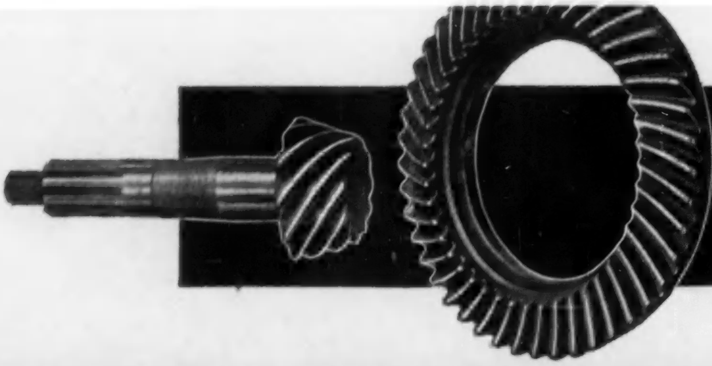
KELLER TOOL

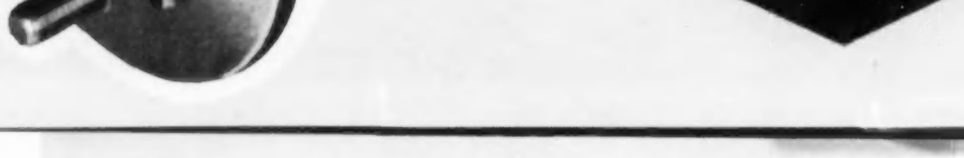
DIVISION OF **GARDNER-DENVER**

GRAND HAVEN, MICHIGAN




A Husky Trio for an Excavator-Crane
Three rugged Clark axles work as a team to drive a big 6 x 6 excavator-crane: a steering-drive axle for the front end, and two non-steer drive axles in tandem at the rear. As always, it's a "quality specification:" CLARK AXLES
CLARK EQUIPMENT
CLARK EQUIPMENT COMPANY • BUCHANAN • Battle Creek, Jackson and Benton Harbor, Michigan





+ INDEX TO ADVERTISERS +

A

AC Spark Plug Div., General Motors Corp. 101
Aeroquip Corp. 147, 148, 149, 150
Aetna Ball & Roller Bearing Co. 183
AiResearch Mfg. Co. 202, 203
American Bosch Div., American Bosch Arma Corp. 142, 152
American Brass Co. 143
American Felt Co. 210
Associated Spring Corp. 144
Auto Specialties Mfg. Co., Inc. 100
Avon Tube Div. 125

B

Bakelite Co., Div. of Union Carbide & Carbon Corp. 121
Bay State Abrasive Products Co. 145
Bendix Aviation Corp.
Products Div. (General Sales) 16
Eclipse Machine Drive Div. 140
Bethlehem Steel Co. 151
Blood Brothers Machine Co. 156
Borg-Warner Corp. 169
Borg & Beck Div., Borg-Warner Corp. 118
Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc. 195
Bridgeport Brass Co. (Aluminum Div.) 132
Bullard Co. 146
Bundy Tubing Co. 172, 173

C

Celanese Corp. of America 98
Central Foundry Div., General Motors Corp. 158, 159
Chase Brass & Copper Co. 145
Clark Equipment Co. 185,186
Curtiss-Wright Corp. 180

D

Dana Corp. 192, 193
Detroit Controls Corp. 109
Dewey & Almy Chemical Co., Div. of W. R. Grace & Co. 188, 189
Doehler-Jarvis Div., National Lead Co. 10, 11
Dole Valve Co. 105
Douglas Aircraft Co., Inc. 205
E. I. du Pont de Nemours & Co., Inc.
Petroleum Chemicals Div. 8
Organic Chemicals Dept. 199

E

Eagle Pencil Co. 115
Eaton Mfg. Co. Axle Div. 14
Enjay Co., Inc. 181
Evans Products Co. (Heating & Ventilating Div.) 166

F

Fafnir Bearing Co. Inside Back Cover
Fairchild Engine & Airplane Corp.
Aircraft Div. 91
Engine Div. 128
Fasco Industries, Inc. 110
Fasteners, Inc. 102
Federal-Mogul Div., Federal-Mogul-Bower Bearings, Inc. 134
Fuller Mfg. Co. 135

G

General Plate Div., Metals & Controls Corp. 12
Goodrich Sponge Products Co., B. F. 146
Goodyear Tire & Rubber Co., Inc. 7
Graton & Knight Co. 142, 190
Great Lakes Steel Corp. 197

H

Heald Machine Co., a Subsidiary of Cincinnati Milling Machine Co. 146
Hunter Spring Co. 96
Hyatt Bearings Div., General Motors Corp. 97

I

Imperial Brass Mfg. Co. 113
Imperial Pencil Tracing Cloth 196
International Nickel Co., Inc. 9
International Packings Corp. 142, 190
The Ivy Co. 196

J

Johnson Bronze Co. 108
Johnson Products, Inc. 112
Johns-Manville Corp. 136
Jones & Lamson Machine Co. 145

K

Keller Tool Div., Gardner-Denver Co. 184
Keuffel & Esser Co. 133

L

Lake Shore, Inc. 196
Lapointe Machine Tool Co. 145
Lebanon Steel Foundry 116
The Leece-Neville Co. 92, 93
Lipe Rollway Corp. 177
Lockheed Aircraft Corp. 157
Lockheed Aircraft Corp., Missile Systems Div. 194
Long Mfg. Div., Borg-Warner Corp. 123

M

McLouth Steel Corp 167
McQuay-Norris Mfg. Co. 119
Marlin-Rockwell Corp. 154
Marquardt Aircraft Co. 201
Marvel-Schebler Products Div., Borg-Warner Corp. 176
The MB Mfg. Co., Inc. 104
Mechanics Universal Joint Div., Borg-Warner Corp. 111
Menasco Mfg. Co. 137
Micromatic Hone Corp. 182
Midland Steel Products Co. 2, 120
Milford Rivet & Machine Co. 143, 201
Milsco Mfg. Co. 205
Moraine Products Div., General Motors Corp. 117
Morse Chain Co. 155

N

New Departure Div., General Motors Corp. 1, 143
National Metal Abrasive Co. 114
National Motor Bearing Co., Inc. 138, 139
North American Aviation, Inc. 170
Norton Co. 146

P

Packard Electric Div., General Motors Corp. 187
Palnut Co. 131
Park Drop Forge Co. 124
Parker Rust Proof Co. 129, 130
Perfect Circle Corp. Inside Front Cover
Precision Rubber Products Corp. 3

R

Republic Aviation Corp. 207
Rochester Products Div., General Motors Corp. 6
Rockford Clutch Div., Borg-Warner Corp. 106
Rohr Aircraft Corp. 168
Ross Gear & Tool Co. 5
Rollway Bearing Co. 191
Ryan Aeronautical Co. 209

S

Saginaw Steering Gear Div., General Motors Corp. 107
Hotel Schroeder 207
Sealed Power Corp. 161
Simplex Piston Ring Mfg. Co. 202
Southwest Products Co. 207
Spencer Thermostat Div., Metals & Controls Corp. 95
Standard Electric Time Co. 144
Sterling Aluminum Products, Inc. 4
P. A. Sturtevant Co. 204

T

Timken Detroit Axle Div., Rockwell Spring & Axle Co. 162, 163
Timken Roller Bearing Co. Outside Back Cover
Tung-Sol Electric, Inc. 99
Tinnerman Products, Inc. 164
The Torrington Co. (Needle Bearings) 141, 160

U

U. S. Axle Co., Inc. 144
U. S. Rubber Co. Naugatauk Chemicals 103, 141, 175
Upholstery Leather Group 165

V

Vickers, Inc. 171

W

Wagner Electric Corp. 178
Waldes Kohinoor, Inc. 153
Wallace & Tiernan Products, Inc. 204
Wausau Motor Parts Co. 126, 127
Western Felt Works 179
Wyman-Gordon Co. 142

Y

Yates-American Machine Co. 194
Young Radiator Co. 174